SERVICE MANUAL

CS-1820

DUAL TRACE OSCILLOSCOPE

TRIO

FEATURES

- The vertical axis provides high sensitivity (5 mV/div) and wide bandwidth 20 MHz (−3dB). [2 mV, 15 MHz (−3 dB) with 5 ► 2 mV switch]
- The CRT has a rectangular with internal graticule, post deflection accelerator with domed mesh to eliminate parallex errors.
- Delay sweep function that enlarges any given portion of signal for easy observation.
- ALT delay sweep function individually sets for delay and nondelay observations of CH1 and CH2 slopes of internal and external sync signals.
- Distortion-free observation of signals up to 20 MHz.
- Selection of 5 sync signals, ALT, CH1, CH2, LINE and EXT.
- Sync coupling for AC, LFREJ, HFREJ, and DC assures stabilized synchronization of various types of waveforms.
- ALT and CHOP switched are provided for ALT or CHOP observation throughout all ranges.
- Auto free-run system enables the trace to be checked even at no-signal time.
- HOLDOFF function for stabilized synchronization of complex signals such as video signals and logic signals.
- X-Y changeover system allows CH1 amplifier to be used as Y axis amplifier and CH2 amplifier as X axis amplifier.
- The adoption of ICs in the logic changeover circuit provides for improved reliability.

CONTENTS

FEATURES 1
SPECIFICATIONS 2
CIRCUIT DESCRIPTION..5
BLOCK DIAGRAM...5
  VERTICAL PREAMPLIFIERS 6
  MODE LOGIC 6
  VERTICAL OUTPUT AMPLIFIER 6
  TRIGGER CIRCUIT 6
  HORIZONTAL SWEEP..7
  DELAY SWEEP CIRCUIT...8
  BLANKING AND INTENSITY CONTROL 8
  POWER SUPPLIES...9
  AUTO FOCUS CIRCUIT..9
MAINTENANCE..10
ADJUSTMENT 12
TROUBLE SHOOTING..18
PARTS LIST...25
P.C.BOARD 32
DISASSEMBLY..37
SCHEMATIC DIAGRAM 39

SPECIFICATIONS

Cathode Ray Tube

Type:
140 CGB 31

Acceleration voltage:
6 kV

Scale:
8 div × 10 div (1 div ≒ 9.5 mm)

Vertical Axis (CH1 and CH2)

Deflection factor:
2 mV/div — 5 V/div ±3%

Attenuator:
5 mV/div to 5 V/div in 1-2-5 sequence.
Variable between ranges, ±5% on all ranges.

Input impedance:
1 MΩ ±2%
Approx. 23 pF

Frequency response:

DC	DC — 20 MHz (within −3 dB) at 5 mV/div — 0.2 V/div [DC — 15 MHz (within −3 dB) at PULL 2 mV/div]
AC	5 Hz — 20 MHz (within −3 dB) at 5 mV/div — 0.2 V/div [5 Hz — 15 MHz (within −3 dB) at PULL 2 mV/div]

Risetime:
23.3 nsec (15 MHz) or less, 17.5 nsec (20 MHz) or less.

Overshoot:
3% or less (100 kHz square wave)

Crosstalk:
Better than −60 dB (alternate), better than −40 dB (chop).

Operating modes:

CH1	CH1 only
CH2	CH2 only
DUAL	Dual trace
ADD	Single trace algebraic sum of CH1 and CH2 (single trace algebraic difference of CH1 and CH2 when CH2 signal is inverted.)

Dual-trace Changeover
TRIG SOURCE in ALT position: Alternate trace
TRIG SOURCE in any position other than ALT: Trace chopped at PULL CHOP.

CHOP frequency:
Approx. 200 kHz

CH2 polarity:
Normal or inverted

Maximum input voltage:
600 Vp-p or 300 V (DC+AC peak)

Maximum undistorted amplitude:
More than 8 div (DC — 20 MHz)

Horizontal Axis (Horizontal input thru CH2 input) [X5 MAG not include]

Deflection factor:
Same as vertical (CH2)

Input impedance:
Same as vertical (CH2)

Frequency response:

DC	DC — 2 MHz (within −3 dB)
AC	5 Hz — 2 MHz (within −3 dB)

X-Y operation:
With SWEEP TIME/DIV switch in X-Y position, the CH1 input becomes the Y-axis input and the CH2 input becomes the X-axis input. The X-Y position control becomes the horizontal position control.

X-Y phase difference:
3° or less at 100 kHz

Sweep Circuit (Common to CH1 and CH2)

Sweep system:
NORM: Triggered sweep.
AUTO: Automatic sweep. Sweep is obtained without input signal.

Sweep time:
0.2 μs/div to 0.5s/div in 20 calibrated ranges, in 1-2-5 sequence. Variable between ranges, Sweep time accuracy; ±3%.

Sweep magnification:
Obtained by enlarging the above sweep 5 times (±10%) from center.

Linearity:
±3% (±10% for 0.5 μs and 0.2 μs/div ranges with ×5 MAG)

Triggering

Source:

Internal:

ALT	Triggered by CH1 or CH2 vertical input signal.
CH1	Triggered by CH1 input signal.
CH2	Triggered by CH2 input signal.
LINE	Triggered by power line frequency.

External:

EXT	Triggered by an external signal applied to EXT TRIG jack.

Maximum input voltage:
50 V (DC+AC peak)

Coupling:
AC, LFREJ, HFREJ, and DC

Sensitivity (Based on sine wave):

Coupling	Bandwidth (Hz)	Minimum Sync Voltage	
		INT (div)	EXT (Vp-p)
AC	20 ~ 15M 10 ~ 20M	0.5 1	1 5
DC	DC ~ 15M DC ~ 20M	0.5 1	1 5
LFREJ HFREJ	Attenuate below 10 kHz. Attenuate above 100 kHz.		

SPECIFICATIONS

Video Sync:

FRAME – LINE switch permits triggering from horizontal (LINE) or vertical (FRAME) sync pulses of composite video signal.

HOLDOFF:

Continuously variable from zero (NORM) to more than 10 times (MAX).

Delay Sweep

Delay time:

1 μs to 100 ms in 5 ranges with vernier adjustment.

ALT:

With ALT triggering source, channel 1 or channel 2 sweep can be independently delayed.

Jitter:

5,000: 1

Intensity modulation:

INTEN switch allows portion of sweep after delay to be intensified.

Calibration voltage:

Square wave, positive polarity
0.5 V ±1%, reference level 0 V
1 kHz ±3%

Intensity Modulation

Input voltage:

More than +2 V (TTL compatible)

Input impedance:

10 kΩ

Bandwidth:

DC – 5 MHz

Maximum input voltage:

50 V (DC+AC peak)

Trace rotation:

Trace angle adjustable on front panel

Power Requirements

Power supply voltage:

AC 100/120/220/240 V ±10%, 50/60 Hz

Power consumption:

Approx. 30 W

Dimensions:

Width: 260 mm (277 mm)
Height: 190 mm (204 mm)
Depth: 375 mm (440 mm)
Figures in ( ) show maximum size.

Weight:

Approx. 8.6 kg

Accessories:

Probe (PC – 22)	2 pieces
	Attenuation 1/10 Input impedance 10 MΩ, less than 18 pF
Replacement fuse	
0.7 A	2
0.3 A	2
Instruction manual	1 copy

SPECIFICATIONS

CRT 140CGB31 SPECIFICATION

Screen and Shape

Dimensions:

Overall length: 310 mm or less

Face plate dimension: Max 143.5 ±1.5 mm

Screen shape:

Rectangular, flat face, internal graticule

Deflection and focusing system:

Electrostatic deflection

Electrostatic focusing

Post-deflection acceleration

Color:

Green

Persistence:

Medium short

Heating

Heater voltage:

6.3 V

Heater current:

0.24A

Mechanical Data

3rd plate voltage (E_{b3}):

Max 6.3 V

2nd plate voltage (E_{b3}):

Max 1800 V

2nd grid voltage (E_{c2}):

Max 1700 V

1st grid voltage (E_{c1}):

Max 200 V

Cathode to heater voltage (Ehk):

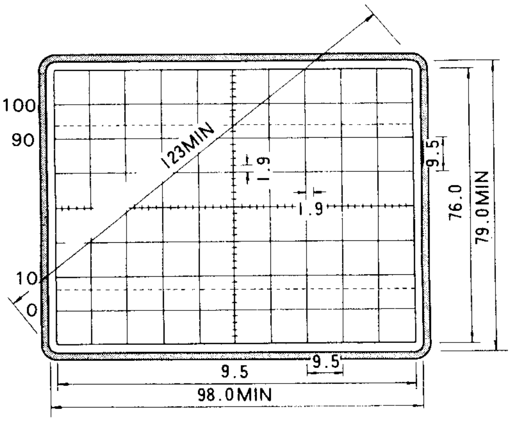
Max 125 V

Voltage between 2nd plate and any deflection plate:

Max 500 V

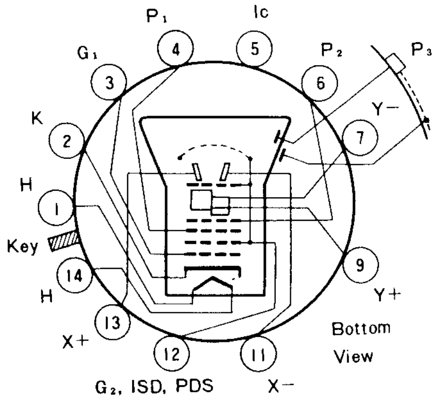
Display area:

95.0 × 76.0 mm^2


100
90
10
0
123MIN
1.9
1.9
9.5
76.0
79.0MIN
9.5
9.5
98.0MIN

(Scale color is black.)

Fig. 1 140CGB31 Graticule


P₁
Ic
G₁
P₂
P₃
4
5
3
6
K
Y−
2
7
H
1
Key
14
9
H
Y+
13
X+
Bottom
View
12
11
G₂, ISD, PDS
X−

When the CRT scale in the normal position, the 3rd plate is found on the left side as viewed from the screen.

Fig. 2 140CGB31 Basing

CIRCUIT DESCRIPTION

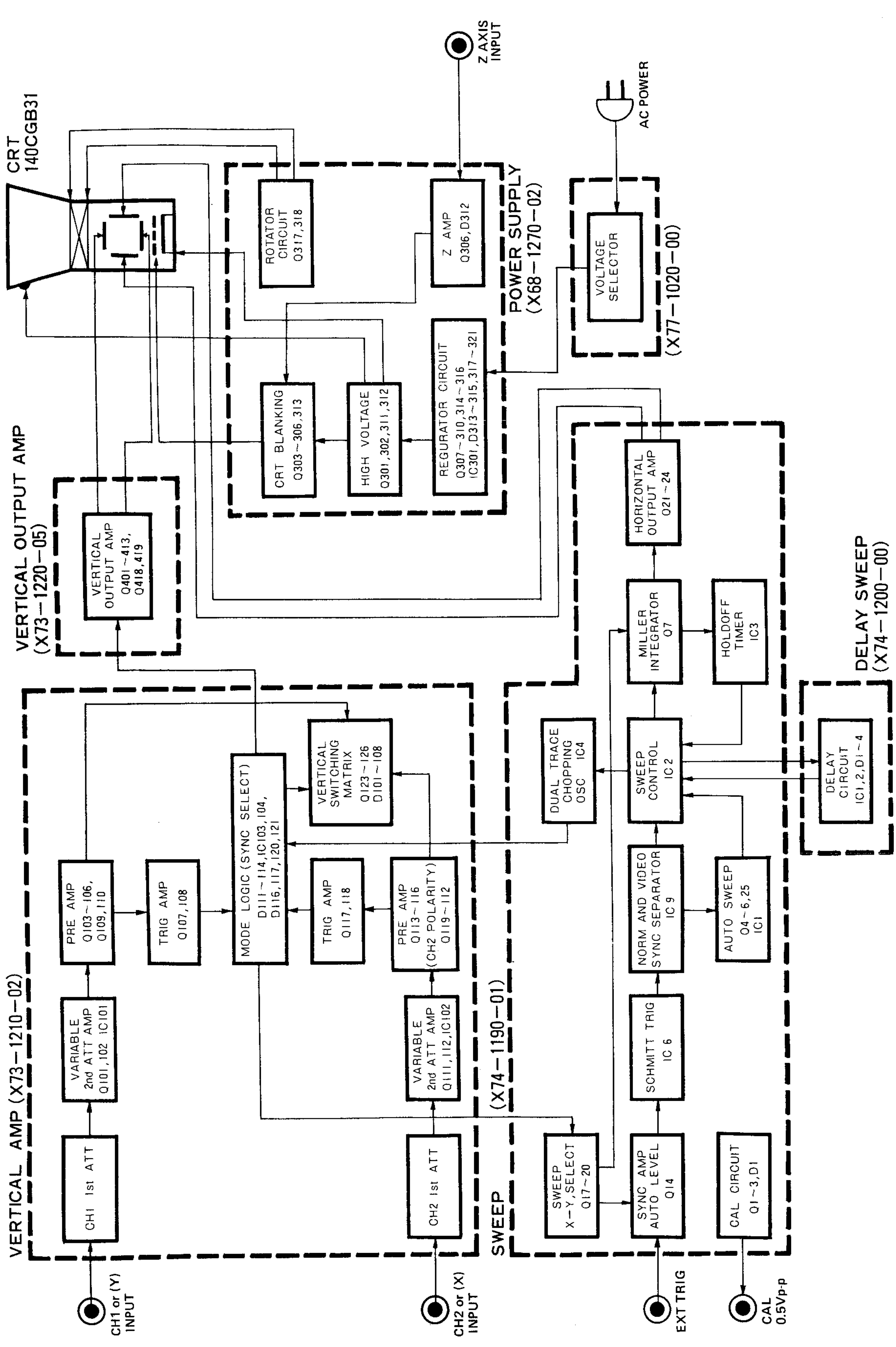

CRT
140CGB31
Z AXIS
INPUT
AC POWER
POWER SUPPLY
(X68-1270-02)
ROTATOR CIRCUIT Q317,318
Z AMP Q306,D312
VOLTAGE SELECTOR
(X77-1020-00)
CRT BLANKING Q303~306,313
HIGH VOLTAGE Q301,302,311,312
REGURATOR CIRCUIT Q307~310,314~316 IC301,D313~315,317~321
VERTICAL OUTPUT AMP
(X73-1220-05)
VERTICAL OUTPUT AMP Q401~413, Q418,419
HORIZONTAL OUTPUT AMP Q21~24
MILLER INTEGRATOR Q7
HOLDOFF TIMER IC3
DELAY SWEEP
(X74-1200-00)
DELAY CIRCUIT IC1,2,D1~4
VERTICAL AMP (X73-1210-02)
CH1 1st ATT
VARIABLE 2nd ATT AMP Q101,102 IC101
PRE AMP Q103~106, Q109,110
TRIG AMP Q107,108
MODE LOGIC (SYNC SELECT) D111~114,IC103,104, D116,117,120,121
VERTICAL SWITCHING MATRIX Q123~126 D101~108
TRIG AMP Q117,118
PRE AMP Q113~116 (CH2 POLARITY) Q119~112
VARIABLE 2nd ATT AMP Q111,112,IC102
CH2 1st ATT
SWEEP (X74-1190-01)
DUAL TRACE CHOPPING OSC IC4
SWEEP CONTROL IC2
NORM AND VIDEO SYNC SEPARATOR IC9
AUTO SWEEP Q4~6,25 IC1
SCHMITT TRIG IC6
SWEEP X-Y,SELECT Q17~20
SYNC AMP AUTO LEVEL Q14
CAL CIRCUIT Q1~3,D1
CH1 or (Y) INPUT
CH2 or (X) INPUT
EXT TRIG
CAL 0.5Vp-p

Fig. 3 BLOCK DIAGRAM

CIRCUIT DESCRIPTION

The block diagram, Fig. 3, outlines the circuit breakdown of the oscilloscope. Circuit details are obtained by reference to the schematic diagram.

VERTICAL PREAMPLIFIERS

The vertical section includes identical networks for Channel 1 and Channel 2, each containing an input attenuator network and preamplifier. The outputs of the preamplifiers can be gated to the vertical drive amp. by the vertical switching matrix. The vertical switching matrix through the MODE switch and vertical mode logic, gates only the Channel 1 signal in CH1 mode and X-Y operation, only the Channel 2 signal in CH2 mode, alternately gates each in DUAL mode, or simultaneously gates both in ADD mode.

Channel 1 and Chnnel 2 preamplifiers contain identical circuitry and circuit operation is the same for both. Channel 1 is described below.

The vertical input attenuator, S103, has two sections. The first provides ratios of 1:1, 10:1, 100:1 and 1000:1. The second section provides ratios of 1:1, 2:1, and 5:1. Together, the two sections give an attenuation sequence or 1-2-5, with the appropriate exponent.

After first attenuation section, FET's Q102a and Q102b form a high-impedance input stage of the vertical preamp. This balanced configuration provides compensation for thermal drift and power supply voltage fluctuations. Q101 and D122 are use for negative over-voltage protection. Positive over-voltage is clamped by Q102a.

Op-amp IC101 feeds the second attenuation section. Q103 thru Q106, Q109 and Q110 further amplify the vertical signal before it reaches the vertical drive amp, transistors Q123 to Q126. Trigger amplifier Q107 and Q108 amplify the signal from the emitters of Q105 and Q106 to provide a signal to the sweep trigger circuits.

The only difference between the CH1 and CH2 preamplifiers is that the CH2 polarity switch, S105, reverses the polarity of the CH2 signal when in the INV position. This is accomplished by switching on either transistor pair Q119/Q122, or Q120/Q121.

MODE LOGIC

The mode of operation (CH1, CH2, DUAL, ADD), S106, is controlled by IC103, IC104, and diodes D101-D108. When CH1 is selected, the IC104 Q output is high and the Q low, which reverse biases D101 and D104, allowing the CH1 signal into the vertical drive amp. D107 and D108 are forward-biased, preventing the CH2 signal from reaching the vertical drive amp. For CH2 mode, the reverse is true. For DUAL mode, both channels are displayed as follows: Below a sweep speed of 0.5 ms/div, the IC104 output switches at a 200 kHz rate. This chops the viewable trace into 5-microsecond segments which are alternately switched between Channel 1 and Channel 2 provide dual trace. The chopping signal (clock pulse) that switches IC104 comes from an oscillator formed by gates IC4a and IC4b, and coupled through IC4c. For sweep speeds greater than or equal to 0.5 ms/div, the IC104 output switches state after every sweep, therefore alternating the A and B vertical signals for dislay. Thus, Channel 1 is viewed during one sweep, and Channel 2 is viewed during the next. The clock pulse to IC104 comes from IC4c.

When ADD mode is selected, the signals from both channels are added algebraically and then applied to the vertical drive amp. In this mode both the Q and Q outputs of IC104 must be high, which is done by setting both the set and reset lines of IC104 low.

VERTICAL OUTPUT AMPLIFIER

The output of vertical amplifier feeds into the vertical output amplifier. Q401 and Q402 form a differential amplifier which goes to another differential stage Q403 and Q404. These connect to emitter followers Q405 and Q406, which drive cascode amplifiers Q408, Q410, and Q409, Q411. Negative feedback from the cascode amplifiers goes via inverters Q412 and Q413. Q412, Q418, and Q413, Q419 comprise current sources for the cascode amplifiers.

TRIGGER CIRCUIT

The channel 1 signal is amplified by trigger amplifier Q107 and Q108 and is available at Q127 as a trigger source. Similarly, the Channel 2 signal is amplified by trigger amplifier Q117 and Q118 and is also available at Q127 as a trigger source. Mode logic IC103 determines which signal shall be selected as the trigger. In the CH1 mode, diodes D117 and D120 are reverse biased which allows the signal from Channel 1 to reach Q127. Diodes D116 and D 121 are forward biased and prevent the Channel 2 signal from reaching Q127. In the CH2 mode, the opposite is true. In the DUAL and ADD modes, an additional input to IC103 from one section of the SOURCE switch selects the Channel 2 signal if the SOURCE switch is set to CH2, but otherwise selects CH1.

The output of Q127 reaches the trigger coupling section via amplifiers Q16 and Q20. The SOURCE switch selects this signal in the CH1 or CH2 positions, an input from the EXT TRIG jack in the EXT position, or a rectified and filtered modulation envelope of the Channel 1 or 2 signal in the DC position. This signal is routed to FET amplifier Q12 through the COUPLING switch. The signal is direct coupled in the DC position, or capacitively coupled in the AC position. The signal is capacitively coupled through a low pass or high pass filter in the HF REJ or LF REJ positions respectively.

The output of Q12 is DC-coupled to emitter follower Q13, which drives one input (pin 2) of op-amp IC5. The triggering LEVEL control sets a DC reference level into the other input of IC5 (pin 1) via Q14a. IC5 acts as a high-gain differential amplifier or Schmitt trigger. When the signal on pin 2 exceeds the DC level on pin 1, the output changes states resulting in a sharp trigger. A trigger of the opposite polarity is developed when the pin 2 level again drops below the pin 1 reference level.

The DC reference from the LEVEL control is disconnected and replaced by a DC voltage at the average of the sync trigger input, which is derived by detecting and filtering the signal in the input of Q14. This establishes the threshold reference for IC5 at the center of the waveform being used for triggering.

Both polarities of the IC5 output are applied to the normal sync gates through Q26 and Q27 SLOPE switch S5a enables normal sync gate IC6b in the + position, allowing the Q26 signal to be gated through IC6c, IC9d, and IC9c. In the – position, IC6d is enabled to allow the Q27 signal to be gated through IC6c, IC9d, and IC9c.

When the FRAME-LINE switch is in the FRAME position, IC inhibits the normal sync signals and allows the video sync circuits (Q15, Q28 and Q29) to supply the sweep trigger. The SLOPE switch selects the + or – polarity output of IC5 as the input to Q15, Q28, and Q29. At sweep times of 0.5 s to .1 ms/div, IC7 and IC12 are turned on, which connects capacitor C65 into the coupling circuit between Q28 and Q29. This capacitor shunts the short-duration horizontal sync pulses and allows the longer-duration vertical sync pulses to reach Q29. These slower sweep times are used for viewing vertical frames or fields of video. At sweep times of 50 μ to .2 μs/div, IC7 and IC12 are turned off and C65 is disconnected. This allows the horizontal sync pulses to reach Q29. These faster sweep times are used for viewing horizontal lines of video.

The trigger pulse output of IC9c is coupled through inverters IC1d and IC1c to the clock input of sweep control multivibrator IC2. This signal synchronizes the sweep to the waveform being used as the trigger source. In the absence of triggering, no sweep is normally developed. However, if PULL AUTO switch S1 is closed, Q6 is enabled and IC2 will free run in the absence of trigger signal. Transistors Q4, Q5, and Q25 when a trigger signal is present.

HORIZONTAL SWEEP

Horizontal deflection is provided by the horizontal preamplifier and horizontal output amplifier. In all except X-Y operation, input to the horizontal preamplifier is furnished by calibrated sweep speed circuits consisting of the sweep control circuit, Miller integrator, and hold-off timer. The sweep can be synchronized to the Channel 1 or 2 input signal or an external trigger. The auto sweep circuit can start the sweep in the absence of a synchronizing trigger. When X-Y operation is selected, the Channel 2 signal is coupled to the horizontal preamplifier for horizontal deflection and the sweep circuits are disabled.

When a trigger pulse is received at the clock input or the reset input of IC2, the Q output (pin 8) goes low. This allows the horizontal ramp integrator to begin the sweep. The integrator consists of Q10, Q11 and the precision sweep timing resistors and capacitors. The sweep speed is determined by the RC time constant of the timing resistors and capacitors set by the SWEEP TIME/DIV control, S2.

The output of the integrator, a decreasing linear ramp, is fed through transistors Q8 and Q9, and then to the horizontal amplifier section, Q17-Q24, and Q31 which drives the horizontal deflection plates. Another output of the sweep integrator, giving an increasing linear ramp, is fed to the threshold input of sweep holdoff timer IC3 (pin 6). When the decreasing ramp voltage has swept the scope trace to the right-hand limit of the sweep cycle on the CRT, the corresponding increasing ramp voltage reaches the threshold setting of IC3. This causes the output of IC3 (pin 3) to go low, which sets the Q output of the sweep control flip-flop, IC2, high. A high at the Q output turns on transistor Q7, which discharges the integrating capacitor and resets the sweep back to the left-hand sweep limit.

Simultaneously with the Q output going high, the Q output of IC2 goes low, which sends a high out of the blanking control gate (IC4 pin 11). This turns the trace intensity down, so you cannot see it being reset to the left side of the CRT.

The sweep holdoff time delay capacitor connected to P7 is discharging through VR207, which went low when threshold was reached at IC3 pin 6. When the holdoff time delay cap has discharged to less than 1.6 volts, the timer output, IC3 pin 3, is triggered high. This arms IC2 for the next trigger pulse, coming either from the clock line input (pin 12) or from the reset input when Q25 of the AUTO TRIGGERING circuit is turned on. Along with pin 3, pin 7 of IC3 also goes high and allows the holdoff time delay capacitor to charge up again. The length of the sweep holdoff is determined by the capacitor tied to IC3 pin 2, and the optimum value for each sweep speed is automatically set by the SWEEP TIME/DIV control.

During X-Y operation, set by the SWEEP TIME/DIV switch, the CH2 trigger amplifier output is fed to the horizontal amplifier via Q19 and Q31. In this mode, the CH2 signal controls the horizontal position of the CRT trace.

1. VIDEO Sync

The TV signal (composite video signal) from the vertical amplifier is fed as an internal sync signal to the sync amplifier IC5. The IC5 produces two output signals; one is the same in phase as the input signal and the other is opposite in phase. These signals are positive sync signal (upper side of composite video signal) and negative sync signal (lower side of composite video signal) with respect to the CH1 and CH2 input composite video signals. The output signals are selected by the polarity select switch according to the input signal to obtain a positive sync signal at all times. The signal thus selected is fed to the vertical sync signal detector circuit (Q15, Q28, Q29) where the vertical sync signal is detected by the integration circuit so that the pulses synchronized with the signal is fed to the sweep control gate IC2.

2. DELAY TRIG

When the sweep circuit is in stand-by state, the FF of IC13 is set to ON. With a trigger signal inputted, the FF of IC13 is set to OFF and, at the same time, the trigger signal is fed to the delay circuit. The delay signal from the delay circuit passes through the NORM/DELAY selecting gate IC10 and is fed to the sweep control gate IC2 for sweep operation. The IC8 receives the vertical switching signal (IC104). This signal is fed to the IC7 and, at the same time, the NORM/DELAY selecting gate IC10 is controlled by the S204 so that the CH1 and CH2 can be individually delayed.

DELAY SWEEP CIRCUIT

When a trigger signal is received from IC13, signal delayed by the CR time constant is fed back from the ICla to the sweep circuit. At this time, the FF of the IC13 is set to OFF by the IC1b until the IC1a is reset. The IC2 gives intensity modulation to the starting point of the delay sweep when the INTEND switch S207 is set in the NORM position. In so doing, the sweep is effected in the NORM mode of the delay select switch. The intensity modulation can be adjusted by the VRI for the desired delay sweep. By setting the delay select switch to the DELAY position, the delay trigger pulse is changed to a sweep trigger pulse so that a delay sweep is effected starting with the intensity modulated portion.

BLANKING AND INTENSITY CONTROL

The DC voltage on the intensity grid (pin 4 of the CRT) sets the intensity of the oscilloscope trace. A square wave signal is pulled off the secondary of the high voltage oscillator transformer T301 and amplified by Q302. The peak-to-peak limits of this square wave are determined by D306, D307, D309, and the intensity and blanking control circuitry Q303, Q304, Q305, and Q313. The square wave is ac-acoupled into peak detector diodes D304 and D305. The negative peak of the square wave sets the DC voltage on the intensity grid. The more negative this voltage goes, the less the intensity. Intensity Adj., VR302, sets the maximum intensity of the trace. The front panel INTENSITY control VR201 adjusts the trace intensity during normal operation by controlling Q303.

The blanking pulse, which turns the trace intensity down during its return to the left-hand side of the CRT after each sweep, and which keeps the trace off prior to the beginning of a sweep, is generated by sweep control flip-flop IC2 and routed through blanking gates IC4c and IC4d. Blanking pulses during the chopping mode of dual-trace operation also come from blanking gates IC4c and IC4d, which are driven by dual-trace chopping oscillator IC4a and IC4b.

Intensity modulation, or the Z-axis signal, is provided by Q306, which DC-couples the Z-axis input jack to, the intensity control circuit.

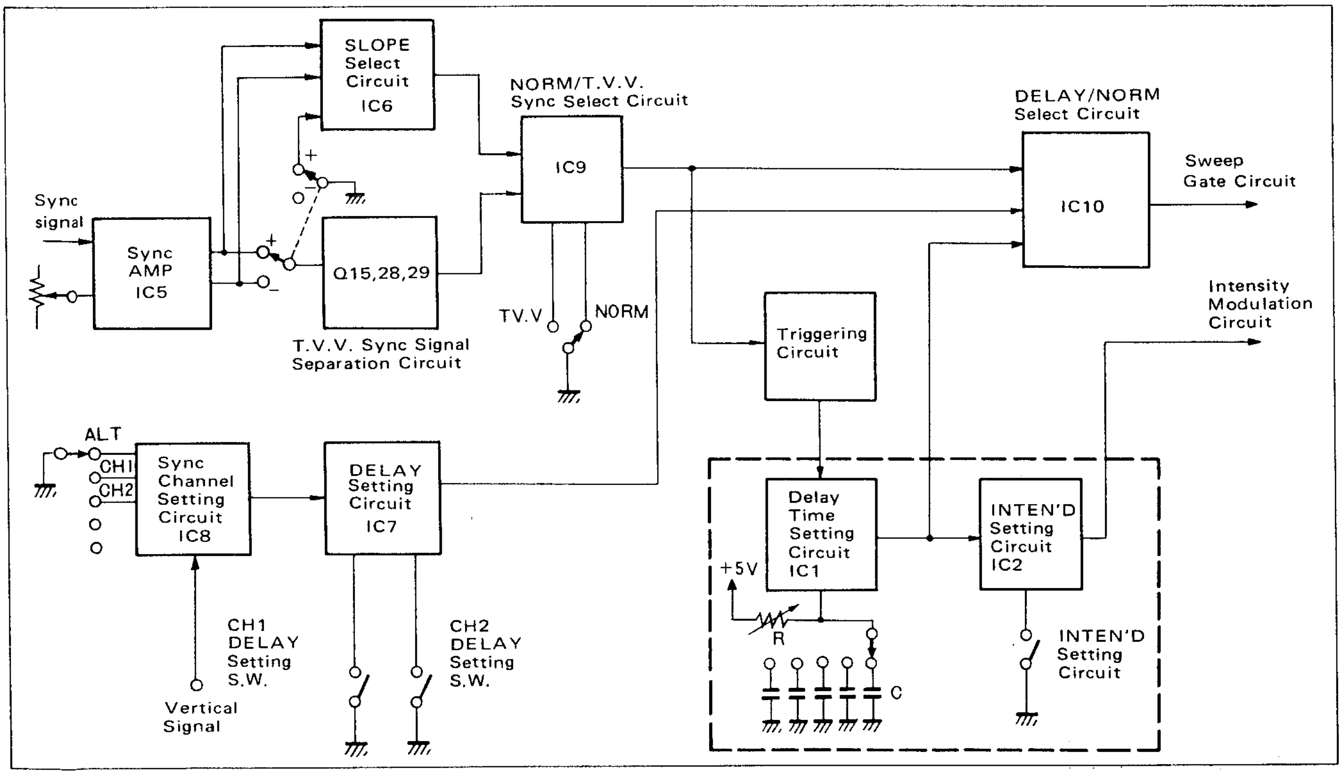

SLOPE Select Circuit IC6
NORM/T.V.V. Sync Select Circuit
IC9
DELAY/NORM Select Circuit
IC10
Sweep Gate Circuit
Sync signal
Sync AMP IC5
+
−
Q15,28,29
T.V.V. Sync Signal Separation Circuit
TV.V
NORM
Triggering Circuit
Intensity Modulation Circuit
ALT
CH1
CH2
Sync Channel Setting Circuit IC8
DELAY Setting Circuit IC7
Delay Time Setting Circuit IC1
+5V
R
C
INTEN'D Setting Circuit IC2
INTEN'D Setting Circuit
CH1 DELAY Setting S.W.
CH2 DELAY Setting S.W.
Vertical Signal

Fig. 4 Delay Sweep Block Diagram

CIRCUIT DESCRIPTION

POWER SUPPLIES

The power supply voltages are fully regulated, and a DC-to-DC converter provides a regulated 6 kV accelerating potential to the CRT.

+ 15 Volt Supply

One output of the 14-volt secondary of the power transformer is rectified by diode bridge D319 to become unregulated + 15 volts. This is also the source for the + 10 volt, + 5 volt, and high voltage supplies.

+ 10 Volt Supply

The unregulated + 15 volt supply is regulated to + 10 volts by Q308, Q315, and Q316.

+ 5 Volt Supply

The regulated + 10 volt output is regulated to + 5 volts by Q307 and Q314.

− 8 Volt Supply

The other output of the 14-volt secondary of the power transformer is also rectified by diode bridge D319 and regulated to − 8 volts by IC301A and Q309.

+ 120 Volt and + 108 Volt Supplies

The 120-volt secondary of the power transformer is rectified by diode bridge D320 and regulated by IC301B and Q310 to + 120 volts. Zener diode D318 drops part of the power supply output to a regulated + 107 volts.

High Voltage Supply

The + 15 volt supply drives a DC-to-DC converter consisting of Q301, Q311, Q312, and T301. Transformer T301 and driver Q301 form an oscillator. Regulation is achieved by feedback transistors Q302, Q311 and Q312. The secondary voltage fo T301 is rectified and filtered as + 4 kV for the anode of the CRT, − 1.3 kV for the cathode, and high voltage for the focus grid. The filaments of the CRT are driven by a secondary of T301, floated at cathode potential.

AUTO FOCUS CIRCUIT

The circuit (Q1, Q2, Q3) is used to invert the intensity modulation signal. The output signal from the circuit varies the amplitude of the oscillator circuit Q4. The voltage set by the FOCUS VR is added to the DC voltage rectified from oscillation waveform and is fed to the FOCUS electrode.

MAINTENANCE

TRACE ROTATION ADJUSTMENT

Strong magnetic fields, present in many locations where an oscilloscope may be used, may cause the trace to be tilted. The degree of tilt may vary as the scope is moved from on location to another. The TRACE ROTATION control provides an electrically adjustable offset to compensate for trace tilt. Perform the adjustment as follows.

1. Set oscilloscope controls to produce a horizontal trace with no input signal (triggering MODE switch in AUTO).
2. Use POSITION controls as required to position the trace along a horizontal line of the graticule scale.
3. Adjust TRACE ROTATION so trace is parallel with the reference line on the graticule scale.

REMOVING THE CASE

> **Caution:**
> A high voltage to 6000 VDC is present on the CRT and power supply board when the oscilloscope is operating. Before removing the case be to turn off the power, and do not touch these parts with hand or a screwdriver even after the case has been removed.

The case is removed in two sections, the top section can be lifted off after removing seven Phillipshead screws from the top and sides of the case. The bottom section can be lifted off after removing four Phillipshead screws from the bottom of the case.

AC VOLTAGE CONVERSION

When operating the unit on voltage other than 240 V, set the AC voltage selector switch to 100 V, 120 V or 220 V according to your local AC current. The voltage selector switch is locate on the rear panel of the unit as indicated by the arrow mark. When operating on 100 V or 120 V, remove the 0.3A fuse and replace it with one rate at 0.7A.

PROBE COMPENSATION

Probe compensation adjustment matches the probe to the input of the scope, For best results, compensation of both probes should be adjusted initially, then the same probe always used with Channel 1 and Channel 2 respectively. Probe compensation should be readjusted whenever a probe from a different oscilloscope is used, or the Channel 1 and 2 probes are interchanged.

1. Connect probes to both INPUT jacks. Connect ground clip of probes to oscilloscope ground terminal and touch tips of both probes to CAL 1 kHz 0.5 V p-p terminal.
2. Select single trace operation of Channel 1, then Channel 2, for steps 3 and 4.
3. Set oscilloscope controls to display 3 or 4 cycles of CAL square wave at 5 or 6 div amplitude.
4. Adjust compensation trimmer on probe for optimum square wave waveshape (minimum overshoot, rounding off, and tilt).

REMOVING THE CATHODE RAY TUBE (CRT) AND P.C. BOARD

> **Caution:**
> This circuits around CRT produce a voltage as high as 6000 VDC. To prevent electric shock, be sure to disconnect the power cord before replacing the CRT. Make certain that the circuits are fully discharged.

REMOVING THE C.R.T.

1. Remove the case (1) and case (2)
2. Remove the CRT bezel.
3. Remove the 2 screws from the CRT band holding the neck of the CRT shield.
4. Remove the 4 screws holding the front panel to the CRT bracket. Then, remove a screw holding a black lead to the leg of the CRT band.
5. Loosen the screw holding the CRT band to the rear panel.
6. Remove the CRT from the CRT socket.
7. Remove the anode cap from the CRT.
8. Lift the CRT shield and slide the CRT forward to remove from the CRT shield and slide the CRT backward to remove from CRT bracket. Remove the tape holding the rotator coil. Slide the rotator coil backward and remove.
9. Remove cable bands using a nipper.
10. The CRT is ready for removal. Replace it with a new one by following the above procedure in reverse order.
11. After replacing, make adjustment of TRACE ROTATION, ASTIG and others referring to the adjustment.

REMOVING THE P.C. BOARD

Removing vertical amplifier board

1. Remove the cases.
2. Remove the decorative panel as follow.
   1) Remove the VOLTS/DIV and VARIABLE knobs (both CH1 and CH2)
   2) Remove the SWEEP TIME/DIV, DELAY TIME knobs and each VARIABLE knobs.
   3) Remove the ⬍ POSITION knobs (both CH1 and CH2)
   4) Remove the SLOPE, COUPLING and SOURCE lever knobs.
   5) Remove the TRIG. LEVEL knob.
   6) Remove the ◄► H.POSITION and HOLDOFF knobs.
   7) Remove the MODE and AC-GND-DC (both CH1 and CH2) lever knobs.
   8) Remove slotted hex. lock nuts from shaft of VOLTS/DIV (CH1 only), ⬍ POSITION (both CH1 and CH2), TRIG. LEVEL, DELAY TIME and ◄► H. POSITION controls.
3. Remove 2 screws securing the each lever switch from diecasting panel.
4. Unsolder 2 resistors (R203, R204) from BNC receptacle.

MAINTENANCE

5. Remove 2 screws, holding the vertical amplifier board, from P.C. board mounting hardware.
6. Carefully disconnect and remove the connector rearward connecting vertical output amplifier board.
7. Carefully disconnect and remove the connector sideward connecting horizontal sweep board.

> **Caution:**
> When disconnecting the connector, carefully disconnect and remove P.C. board to avoid damage of the P.C. board.

Removing horizontal sweep board

1. Remove the case and decorative panel (this is the same procedure that was removed in step 1 and 2 of "Removing vertical amplifier board".
2. Remove each 2 screws securing SLOPE, COUPLING and SOURCE lever switches from die-casting panel.
3. Remove slotted hex. lock nuts from shaft of SWEEP TIME/DIV and HOLDOFF controls.
4. Disconnect the connectors from the terminals. (1—8, 10—12, and 16)
5. Unsolder resistor (R47) from BNC (EXT. TRIG) receptacle.
6. Removing 2 screws, holding the horizontal sweep board from P.C. board mounting hardware.
7. Carefully disconnect and remove J1 and J2 connectors connecting the vertical amplifier board and power supply board.
8. Unplug P1 thru P8 from horizontal sweep board.

Removing vertical output amplifier board

1. Remove the cases.
2. Unsolder 2 yellow leads from CRT socket.
3. Remove 2 screws, securing CRT band from rear panel.
4. Remove 2 CRT bracket.
5. Carefully disconnect and remove J401 and J402 connectors connecting the vertical amplifier board and power supply board.

ADJUSTMENT

To obtain the best performance, periodically calibrate the unit. Sometimes, only one mode need be calibrated, while at other times, all modes should be calibrated. When one mode is calibrated, it must be noted that the other modes may be affected. When calibrating all modes, perform the calibration in the specified sequence.

The following calibration required an accurate measuring instrument and an insulated adjusting flat blade screwdriver. If they are not available, contact your dealer.

For optimum adjustment, turn the power on and warm up the CS-1820 sufficiently (more than 30 minutes) before starting.

Before calibrating the unit, check the power supply voltage.

TEST EQUIPMENT REQUIRED

The following instrument or their equivalent should be used for making adjustment.

Test Equipment	Model	Minimum Specification
Digital Multi-Meter	DL-706 (TRIO)	Impedance: More than 10 MΩ, Measuring range: 0.01 V to 199 V
Sine-Wave Generator	651 B (YHP)	Frequency: 10 Hz to 10 MHz, constant voltage over tuning range
Sine-Wave Generator	SG-503 (Tektronix)	Frequency: 50 kHz to 100 MHz, Output impedance: 50 Ω, constant voltage over tuning range.
Square-Wave Generator	PG-506 (Tektronix)	Output signal: 1 kHz, Amplitude: 10 mVp-p to 10 Vp-p, Accuracy: within ±1%, Rise time: 35ns or less
Q Meter	4343B (YHP)	—
Color Pattern Generator	CG-911 (TRIO)	—
Oscilloscope	465 (Tektronix)	Sensitivity: more than 5 mV Frequency response: More than 100 MHz
Time-Marker Generator	TG-501 (Tektronix)	Time mark: 0.5 s to 0.1μs repetive waveform
High-Voltage Probe	—	Input Impedance: 1000 MΩ
Termination	—	Impedance: 50 Ω Accuracy: within 3%
Termination	—	3 watts type impedance: 50 Ω
Attenuator	—	−20 dB attenuation (50 Ω)

PREPARATION FOR ADJUSTMENT

Control Setting

The control setting listed below must be used for each adjustment procedure.

Exceptions to these settings will be noted as they occur.

After completing a adjustment, return the controls to the following settings.

NAME OF KNOBS	POSITION
INTENSITY	3 o'clock
FOCUS	Optimum position
CH1,CH2 POSITION/ PULL5▷2mV	Mechanical position and push
◄► H. POSITION/PULL ×5MAG	Mechanical position and push
VARIABLE (H, V)	CAL
AC-GND-DC (CH1 and CH2)	DC (GND at no signal)
MODE	CH1
CH2 POLARITY	NORM
SLOPE	+
COUPLING	AC
SOURCE	ALT
TRIG. LEVEL/PULL AUTO	Mechanical center and pull
HOLDOFF/PULL CHOP	NORM and push
FRAME-LINE	LINE
INTEN'D	NORM
CH1 (CHOP)	NORM
CH2	NORM
VOLTS/DIV	5 mV/DIV
SWEEP TIME/DIV	1 ms/DIV

ADJUSTMENT

Item	Adjustment control	Adjustment and check	Remark
POWER AND CRT CIRCUIT ADJUSTMENTS (X68-1270-02)			
+108.5 V, +10 V, +15 V, +5 V, −8 V and +124 V adjustments and check.	**VR304**	1. Connect a DC voltmeter to measure the voltage at the pin 8 of P308 with respect to the chassis. 2. Adjust **VR304** to obtain +108.5 V ±1% 3. Next, measure the voltages at the pin 4, 7 and 8 of P306. The voltage should be +10 V, +15 V, +5 V, −8 V and +124 V respectively.	
−1.5 kV adjustment	**VR303**	1. Connect a DC voltmeter to measure the voltage at the pin 9 of P301 on the high voltage power supply unit with respect to the chassis. 2. Adjust **VR303** to obtain −1.5 kV.	Caution: Be sure to use the high-voltage prove.
FOCUS and ASTIG adjustments	**FOCUS** **ASTIG**	1. Set the SWEEP TIME/DIV control to the X-Y position and CH1 and CH2 AC-GND-DC switches to the GND position. This will produce a spot on the screen. 2. Adjust the FOCUS and ASTIG on the front panel for the sharpest, roundest spot.	Do not readjust the ASTIG contro after this step.
INTENSITY adjustment	**VR302**	1. Set the TRIG. MODE switch to the AUTO position to display a trace. 2. Adjust **VR302** so that the trace disappears when the INTENSITY control setting is reduced to the 10:30 o'clock position.	
Blanking adjustment	**TC301**	1. Set the SWEEP TIME/DIV control to 0.2 μs and the TRIG. MODE switch to the AUTO to display a trace. 2. Adjust **TC301** until the start point of the trace is the same in thickness as the other.	
Check of CRT centering		1. Short test terminal **P401** to **P402** (vertical output amplifier board). 2. Pull the PULL AUTO knob to display a trace. 3. Check the trace to center the trace vertically.	
VERTICAL AXIS CIRCUIT ADJUSTMENT (X73-1210-02)			
VARI. ATT. BAL. and STEP ATT. BAL. adjustments	**VR101** **VR103** **VR108** **VR110**	1. Set scope control for a single horizontal trace on CH1 with the CH1 AC-GND-DC switch set to the GND position and set the SWEEP TIME/DIV control to 1 ms. 2. Rotate the CH1 variable control from maximum clockwise to maximum counterclockwise, while observing the trace. 3. If the trace moves vertically, adjust **VR101** (VARI. ATT. BAL.) for minimum or zero movement when performing step 2. 4. Rotate the CH1 VOLTS/DIV switch through the 5 mV, 10 mV and 20 mV position while observing the trace. 5. If the trace moves vertically, adjust **VR103** (STEP ATT. BAL.) for minimum of zero vertical movement when performing step 4. 6. Repeat the entire procedure for CH2, adjusting **VR108** for VARIABLE balance and **VR110** (VOLTS/DIV) step balance.	After adjusting VARI., be sure adjust STEP.

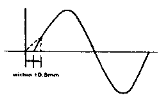
ADJUSTMENT

Item	Adjustment control	Adjustment and check	Remark
2 mV Center adjustment	**VR115**	1. Set the CH1 AC-GND-DC switch to the GND position and the SWEEP TIME/DIV control to the 1 ms position. 2. Adjust the **VR114** so that the trace is stationary when the CH1 VOLTS/DIV control is set to the 2 mV or 5 mV position. 3. Repeat the entire procedure for the CH2, adjusting **VR115**.	
CH2 INVERT POLARITY and ⬍ POSITION adjustments	**VR112** **VR105** **VR402**	1. Set the CH1 AC-GND-DC switch to the GND, the MODE switch to the DUAL position, and the SWEEP TIME/DIV control to 1 ms. Also, set the TRIG. AUTO switch to the AUTO position. 2. Next, adjust **VR112** to make sure that the trace does not sift when the CH2 POLARITY push button switch is set in the PUSH position (INV) (■). 3. Set the CH2 and CH1 ⬍ POSITION controls to these mechanical center. 4. Adjust **VR105** and **VR402** so that traces are overlapped in the center of the scale.	
Vertical gain adjustment	**VR401** **VR110**	1. Set the MODE switch to the CH2 position. 2. Apply the CH2 input terminal to 1 kHz square wave signal. 3. Set the CH1 VARIABLE control to the CAL position and the VOLTS/DIV control to 5 mV. 4. Adjust **VR401** for exactly 4 divisions vertical amplitude of 1 kHz square wave signal display . 5. Repeat the entire procedure for CH1, adjusting **VR110** for vertical gain adjustment.	
100 kHz square wave compensation	**TC401** **TC402** **TC403** **TC405** **VR403** **VR404** **VR405**	1. Set the VOLTS/DIV control to 5 mV, the MODE switch to CH2 position and the SOURCE switch to CH2 position. 2. Apply a 100 kHz square wave signal through a 50 Ω terminator to the CH2 input terminal and adjust the vertical amplitude to 6 divisions on the CRT screen. 3. Rotate the SWEEP TIME/DIV control from 2 μs to 0.2 μs. Adjust **TC401** thru **TC405** and **VR403** thru **VR405** in the order (a to d),to obtain the optimum waveform at the rising portion of the square wave. a. Adjust **VR404** to obtain flat mid range. b. Adjust **TC403** to obtain flat mid and high ranges. c. Adjust **TC402** to obtain maximum overshoot. d. Adjust **VR405** and **VR403** to obtain minimum overshoot.	
1 kHz square wave compensation	**TC101** **TC103** **TC105** **TC106** **TC108** **TC110**	1. Set the VOLTS/DIV control to 5 mV and apply a 1 kHz square wave signal. 2. Rotate the VOLTS/DIV control to 50 mV (10:1), 0.5 V (100:1) and 5 V (1000:1) positions. 3. Adjust **TC101** (10:1), **TC103** (100:1) and **TC105** (1000:1) to make sure that the vertical amplitude is set to 6 divisions on the CRT screen.	

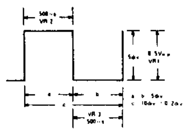
ADJUSTMENT

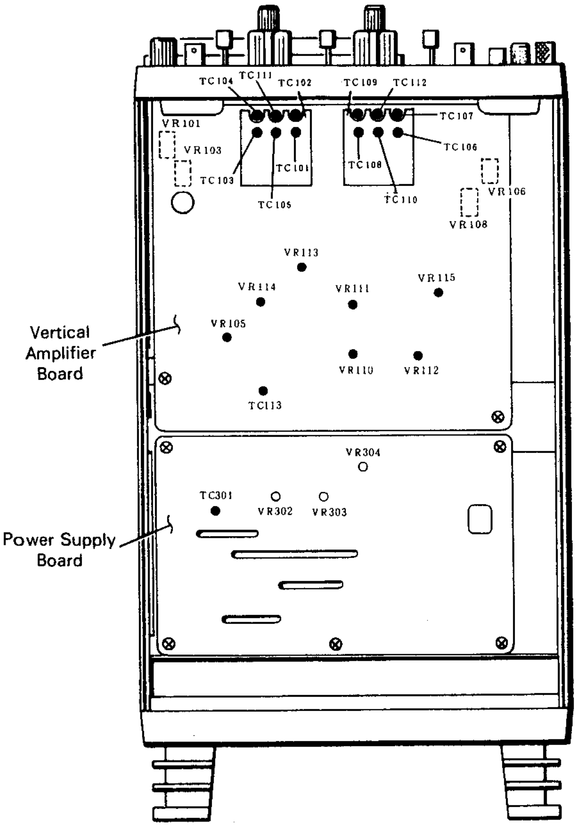
Item	Adjustment control	Adjustment and check	Remark
		4. Repeat the entire procedure for CH2, adjusting **TC106** (10:1), **TC108** (100:1) and **TC110** (1000:1)	
Input capacity adjustment	**TC102** **TC104** **TC111**	1. Connect a "Q" meter to measure the input capacity at the CH1 input terminal and make sure that the input capacity is approx. 23 pF. 2. Rotate the VOLTS/DIV control to 50 mV (10:1), 0.5 V (100:1) and 5 V (1000:1), adjusting **TC102**, **TC104** and **TC111** to make sure that the input capacity at each position is the same as that at the 5 mV (1/1) position.	
HORIZONTAL AXIS CIRCUIT ADJUSTMENT (X74-1190-01)			
Waveform spacing adjustment	**TC4**	1. Set the SWEEP TIME/DIV control to the 0.2 μs position and the PULL×5 MAG knob to the PULL position. 2. Apply a 20 MHz sine wave signal to the V. INPUT to display 2 div vertical amplitude waveform on the screen. 3. Adjust the **TC4** to set the starting point and spacing of waveforms.	
Sweep time and sweep length adjustments	**VR15** **VR6**	1. Set the SWEEP TIME/DIV control to 1 ms and apply a 1 ms marker signal to the CH1 input terminal. 2. Adjust **VR15** so that a pulse appears on each division on the graticule scale of the CRT screen. 3. Next, adjust **VR6** so that the sweep length slightly exceeds 9 divisions (approx. 9.5 divisions, SWEEP TIME/DIV:0.5 μs –0.1 μs not included)	
MAG centering and MAG GAIN adjustments	**VR13** **VR14**	1. With the SWEEP TIME/DIV control to 1 ms, apply a 5 ms marker signal to the CH1 input terminal to display 5 pulses on the CRT screen. 2. Pull the X5 MAG knob to magnify a trace and adjust so that the center of the wave corresponds to the Y-axis on the graticule scale. 3. Push the X5 MAG knob and adjust **VR13** so that the center of the trace corresponds to Y-axis on the graticule scale. 4. Next, set the SWEEP TIME/DIV control to 1 ms. 5. With a 1 ms marker signal applied to the CH1 input terminal, adjust **VR14** until the center of the 3 pulses corresponds to the Y-axis on the graticule scale.	
◄► H. POSITION adjustments	**VR10**	1. With the SWEEP TIME/DIV control set to 1 ms, apply 5 ms marker signal to the CH1 to display 3 pulses on the CRT screen. 2. Next, set the ◄► H. POSITION control to its mechanical center, and adjust **VR10** until the center of the 3 pulses corresponds to the Y-axis on the graticule scale.	
1 μs, 0.5 μs and 0.2μs range adjustments	**TC1** **TC2** **VR5**	1. Set the SWEEP TIME/DIV control to 1 μs, 0.5 μs and 0.2 μs while applying the corresponding marker signal (1 μs, 0.5 μs and 0.2μs) to display 10 waves on the CRT screen. 2. Adjust **TC1**, **TC2** and **VR5** so that each wave is 9 divisions on the glaticule scale respectively.	

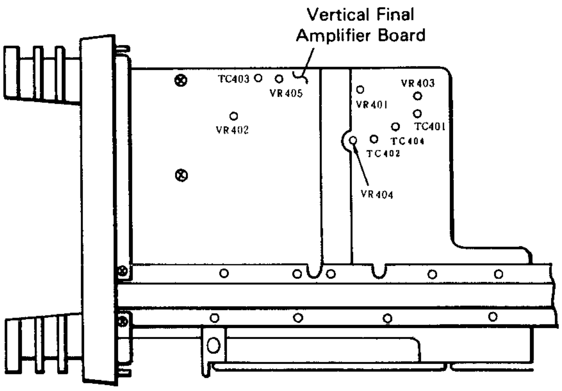
ADJUSTMENT

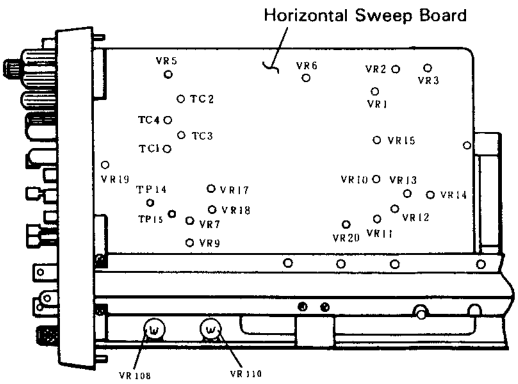
Item	Adjustment control	Adjustment and check	Remark
Starting Point adjustment	TC3 TC4	1. Set the SWEEP TIME/DIV control to the 20μs position and the ◁ ▷ H. POSITION/PULL × 5 MAG knob to the PULL position. 2. Apply to 250 kHz sine wave signal to the V. INPUT to display a 6 div vertical amplitude waveform on the screen. 3. Adjust the **TC3** to obtain the waveform starting point as illustrated right. 4. Next, set the SWEEP TIME/DIV control to the 0.2μs position. 5. Apply a 20 MHz sine wave signal to the V. INPUT to display a 2 div vertical waveform. Make even the spacing in the vicinity of the starting point. 6. Adjust the **TC4** so that the optimum starting point is obtained when the ◁ ▷ H. POSITION/PULL × 5MAG knob is set to PULL and PUSH positions.	
X POSITION adjustment	VR12	1. With the MODE switch set to the DUAL position, overlap the traces of both channels using the CH1 and CH2 ⬍ POSITION controls. 2. The traces should coincide with the X-axis on the graticule scale. 3. Set the SWEEP TIME/DIV control to the X-Y operation and adjust **VR12** to bring the spot in the center of the graticule scale.	
X GAIN adjustment	VR111	1. Set the SWEEP TIME/DIV control to the X-Y operation and the CH2 VOLTS/DIV control to 5 mV. 2. Apply a 1 kHz, 20 mV square wave to the CH2 input terminal and adjust **VR111** for exactly 4 divisions horizontal deflection.	
SYNC ADJUSTMENT			
OFF-SET adjustment	VR7	1. Set the TRIG LEVEL knob to its mechanical center position and short the shorting terminals P14 kand P15. Then, connect a calibrated oscilloscope (sensitivity: 0.2V/div, AC-GND-DC). 2. Adjust the **VR7** so that the voltage on the P13 is not varied when the SLOPE knob is set to "+" and "−" positions.	
TRIG LEVEL Center adjustment	VR19	1. Set the TRIG LEVEL control to its mechanical center position. Adjust the **VR19** so that the voltage on the P13 remains unchanged when the shorting pins P14 and P15 are removed.	
"+" and "−" TRIG adjustment	VR17 VR18	1. Set the TRIG LEVEL control to its mechanical center position. Apply a 1 kHz sine wave signal to the CH2 INPUT to display a 6 div vertical amplitude waveform. 2. Reduce the amplitude gradually and adjust the **VR18** so that the signal is triggered below 0.5 div. 3. Repeat the entire procedure for the "−" TRIG., adjusting **VR17**.	**Check** that the starting point remains the same when the SLOPE switch is set to the "+" and "−" positions.

ADJUSTMENT

Item	Adjustment control	Adjustment and check	Remark
CH2 DC COUPLING adjustment	**VR11** **VR20**	1. Set the MODE switch to the CH2 position. 2. Apply a 1 kHz sine wave signal to the CH2 to display a 6 div vertical amplitude waveform on the scope. 3. Set the **VR20** to its mechanical center position and adjust the **VR11** so that the waveform starting point is not changed.	If this adjustment is not possible with the **VR11**, use the **VR11** and **VR20** alternately.
CH1 DC COUPLING adjustment	**VR113**	1. Set the MODE switch to the DUAL position and the COUPLING switch to the DC position. 2. Apply a 1 kHz sine wave signal to the CH1 and CH2 to display a 6 div vertical amplitude waveform on the scope. 3. Adjust the **VR113** so that the waveform starting points of CH1 and CH2 are the same.	
CALIBRATING VOLTAGE ADJUSTMENTS (X74-1190-00)			
	VR1 **VR2** **VR3**	1. With a 1 kHz, 0.1 V square signal applied to well calibrated oscilloscope, set the VOLTS/DIV control to 20 mV to display a waveform on the CRT screen as illustrated below. 2. Next, apply a calibrating voltage (⎍ CAL output) of the unit to the oscilloscope and adjust **VR1**, **VR2** and **VR3** until the displayed.	 500 μs VR2 5div 0.5Vp-p VR1 a b c a = b = 5div c = 10div ± 0.2div VR3 500 μs

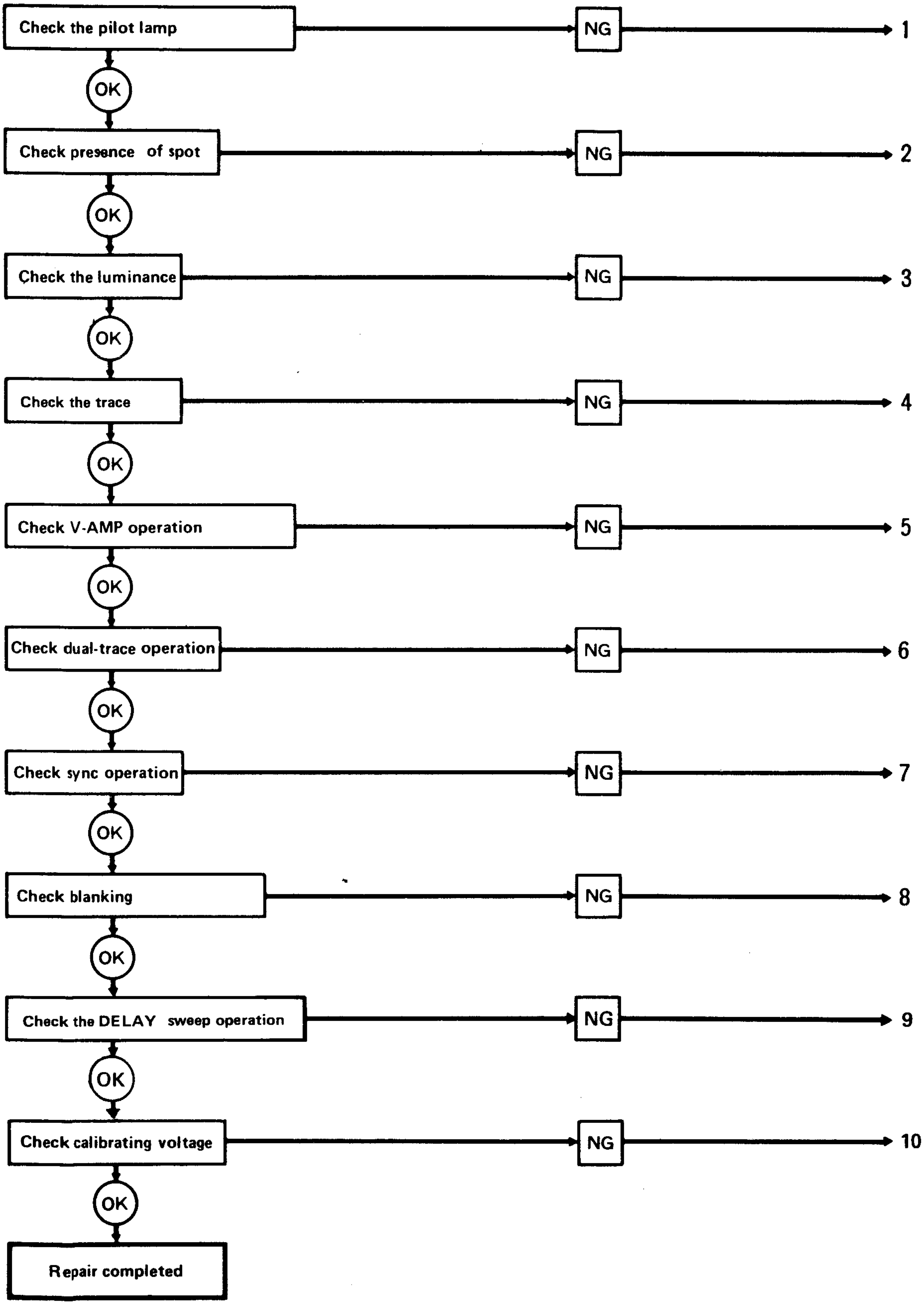

TC104
TC111
TC102
TC109
TC112
TC107
VR101
VR103
TC106
TC101
TC108
TC103
TC105
TC110
VR106
VR108
VR113
VR114
VR111
VR115
Vertical Amplifier Board
VR105
VR110
VR112
TC113
VR304
TC301
VR302
VR303
Power Supply Board


Vertical Final Amplifier Board
TC403
VR405
VR403
VR401
VR402
TC401
TC404
TC402
VR404


Horizontal Sweep Board
VR5
VR6
VR2
VR3
TC2
VR1
TC4
TC3
VR15
TC1
VR19
TP14
VR17
VR10
VR13
VR14
TP15
VR18
VR7
VR12
VR20
VR11
VR9
VR108
VR110

TROUBLESHOOTING

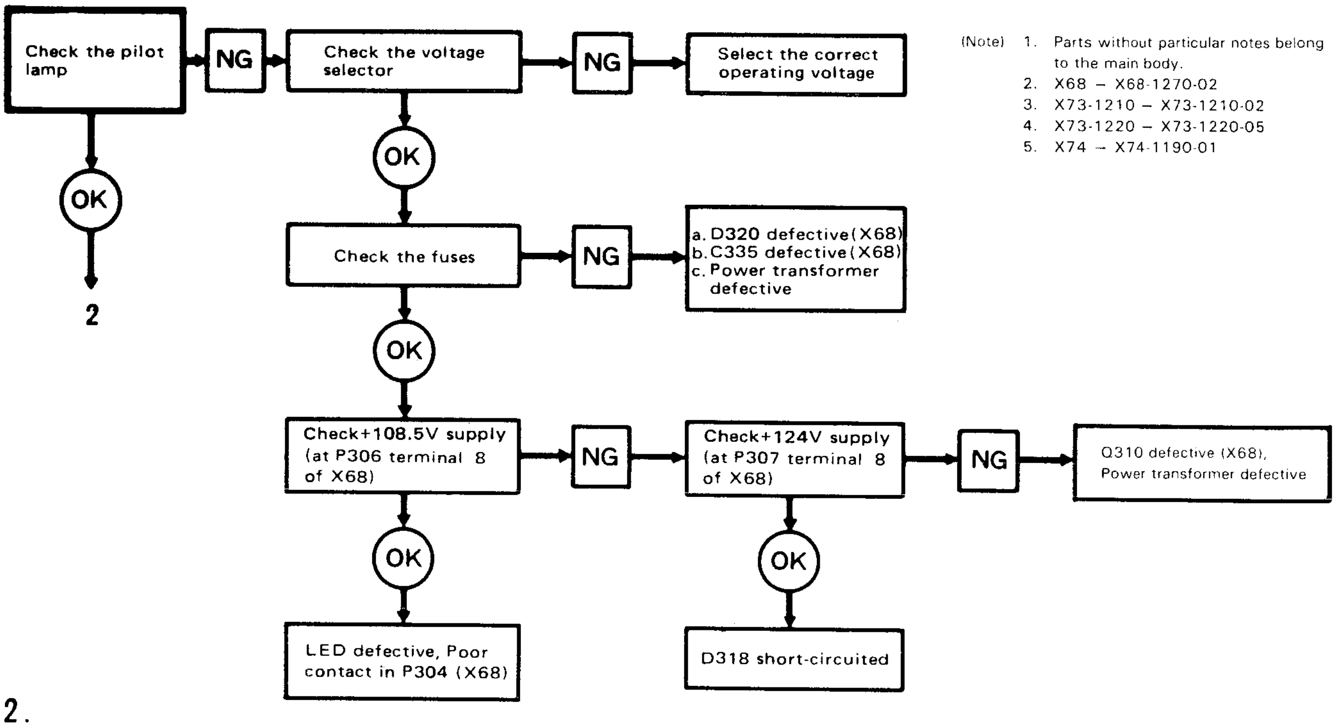
TROUBLESHOOTING


Check the pilot lamp
NG
1
OK
Check presence of spot
NG
2
OK
Check the luminance
NG
3
OK
Check the trace
NG
4
OK
Check V-AMP operation
NG
5
OK
Check dual-trace operation
NG
6
OK
Check sync operation
NG
7
OK
Check blanking
NG
8
OK
Check the DELAY sweep operation
NG
9
OK
Check calibrating voltage
NG
10
OK
Repair completed

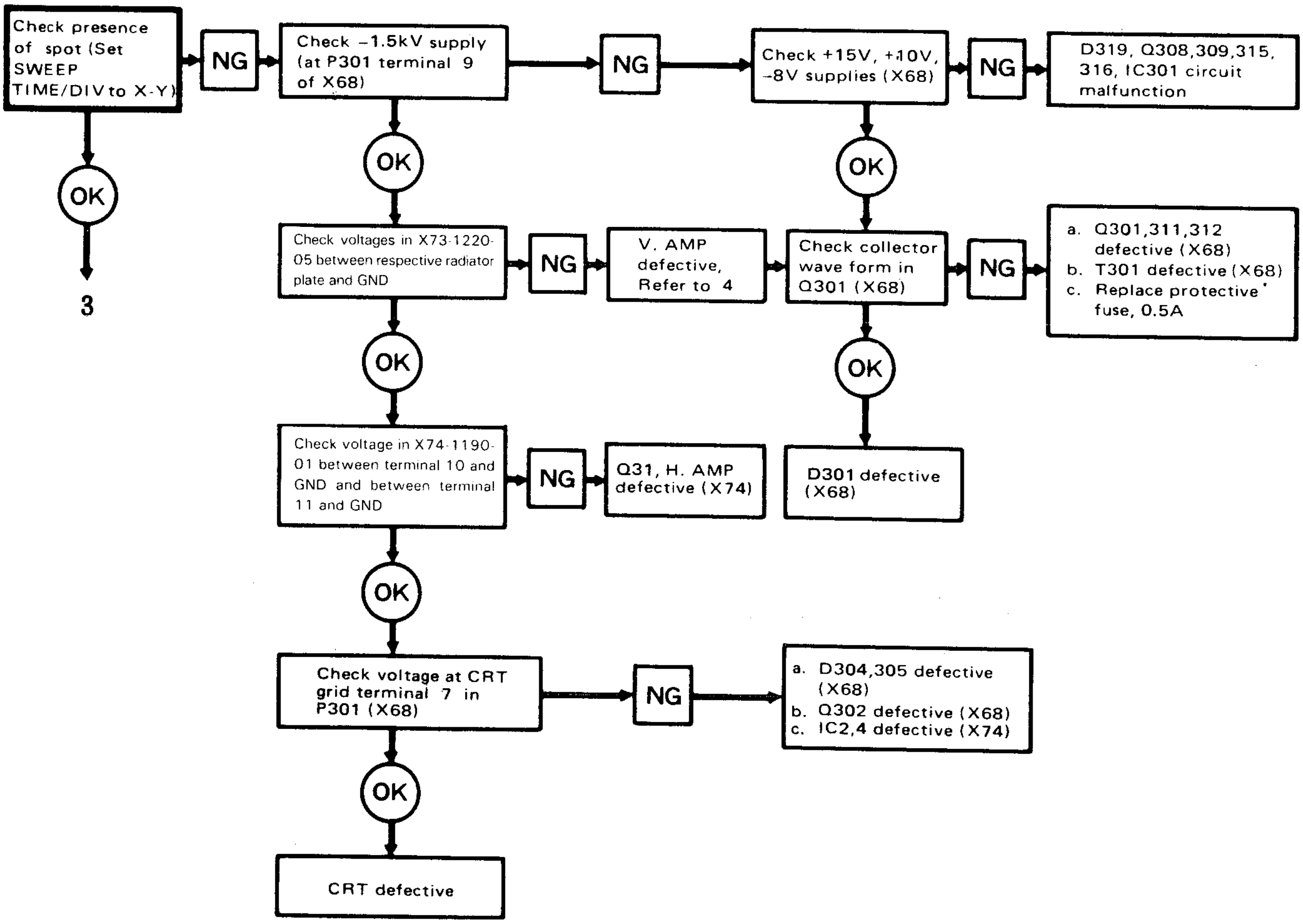
TROUBLESHOOTING

(Note)
1. Parts without particular notes belong to the main body.
2. X68 – X68-1270-02
3. X73-1210 – X73-1210-02
4. X73-1220 – X73-1220-05
5. X74 – X74-1190-01

1.

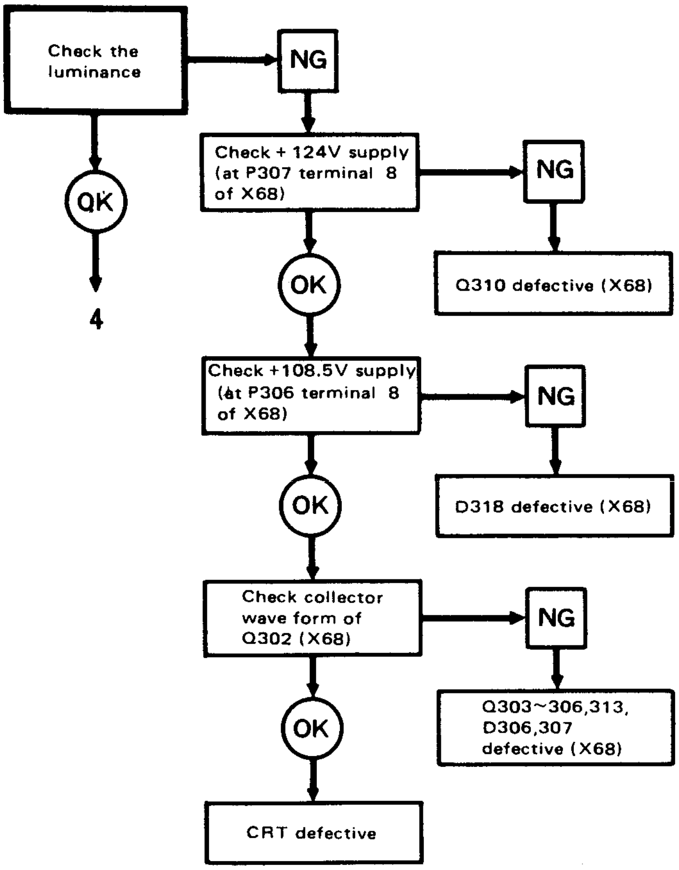

Check the pilot lamp
NG
Check the voltage selector
NG
Select the correct operating voltage
OK
2
OK
Check the fuses
NG
a. D320 defective (X68)
b. C335 defective (X68)
c. Power transformer defective
OK
Check+108.5V supply (at P306 terminal 8 of X68)
NG
Check+124V supply (at P307 terminal 8 of X68)
NG
Q310 defective (X68), Power transformer defective
OK
LED defective, Poor contact in P304 (X68)
OK
D318 short-circuited

2.


Check presence of spot (Set SWEEP TIME/DIV to X-Y)
NG
Check –1.5kV supply (at P301 terminal 9 of X68)
NG
Check +15V, +10V, –8V supplies (X68)
NG
D319, Q308,309,315, 316, IC301 circuit malfunction
OK
3
OK
Check voltages in X73-1220-05 between respective radiator plate and GND
NG
V. AMP defective, Refer to 4
OK
Check collector wave form in Q301 (X68)
NG
a. Q301,311,312 defective (X68)
b. T301 defective (X68)
c. Replace protective fuse, 0.5A
OK
Check voltage in X74-1190-01 between terminal 10 and GND and between terminal 11 and GND
NG
Q31, H. AMP defective (X74)
OK
D301 defective (X68)
OK
Check voltage at CRT grid terminal 7 in P301 (X68)
NG
a. D304,305 defective (X68)
b. Q302 defective (X68)
c. IC2,4 defective (X74)
OK
CRT defective

TROUBLESHOOTING

3.


Check the luminance
NG
OK
4
Check + 124V supply (at P307 terminal 8 of X68)
NG
Q310 defective (X68)
OK
Check +108.5V supply (at P306 terminal 8 of X68)
NG
D318 defective (X68)
OK
Check collector wave form of Q302 (X68)
NG
Q303~306,313, D306,307 defective (X68)
OK
CRT defective

4.

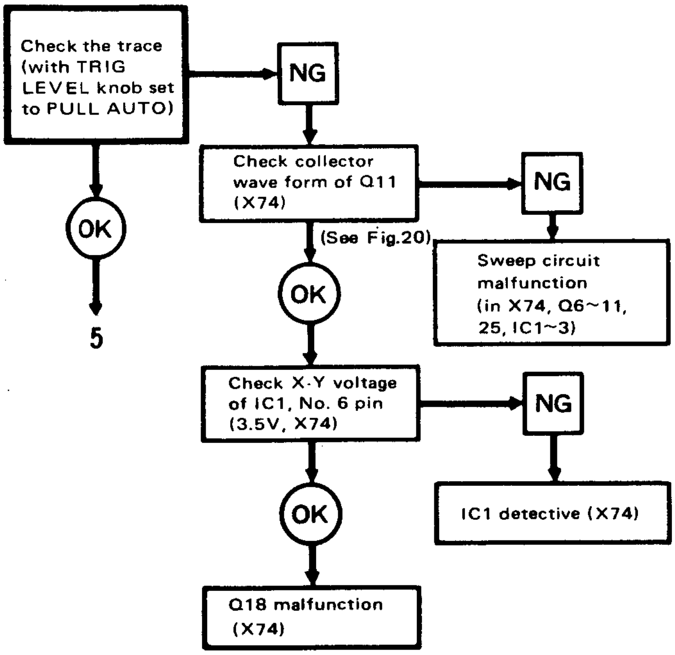
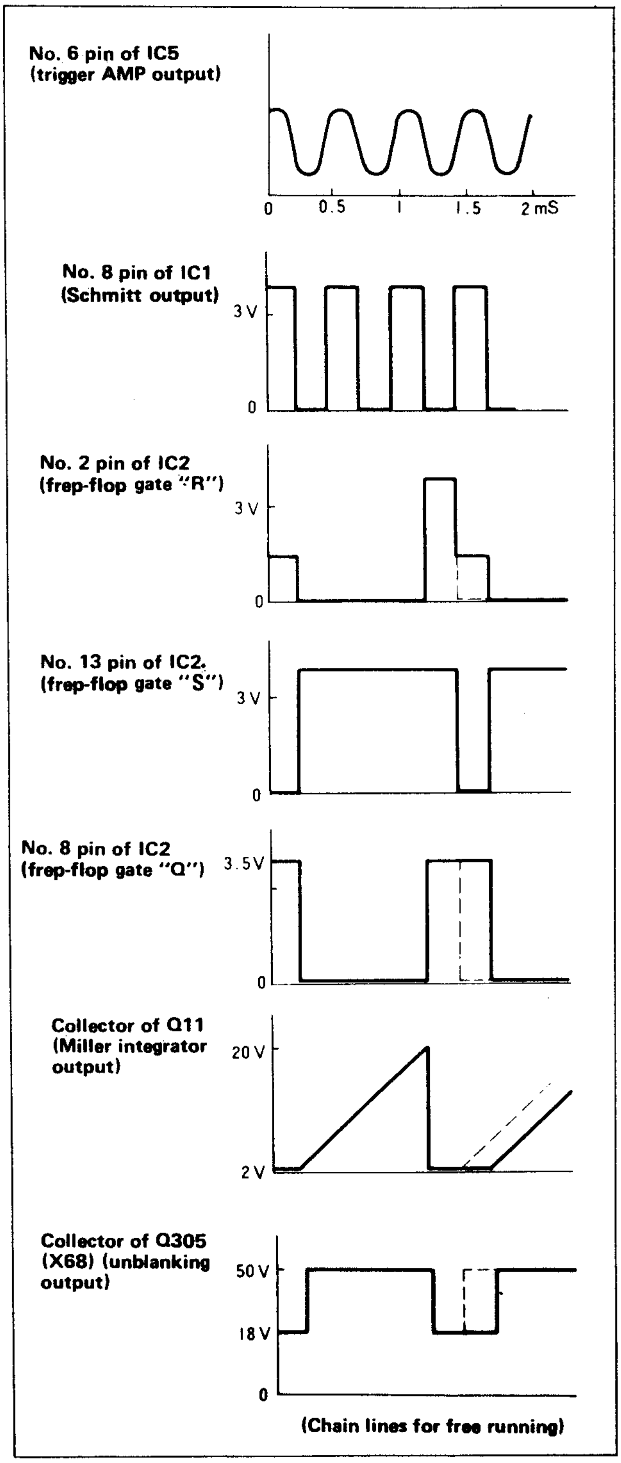
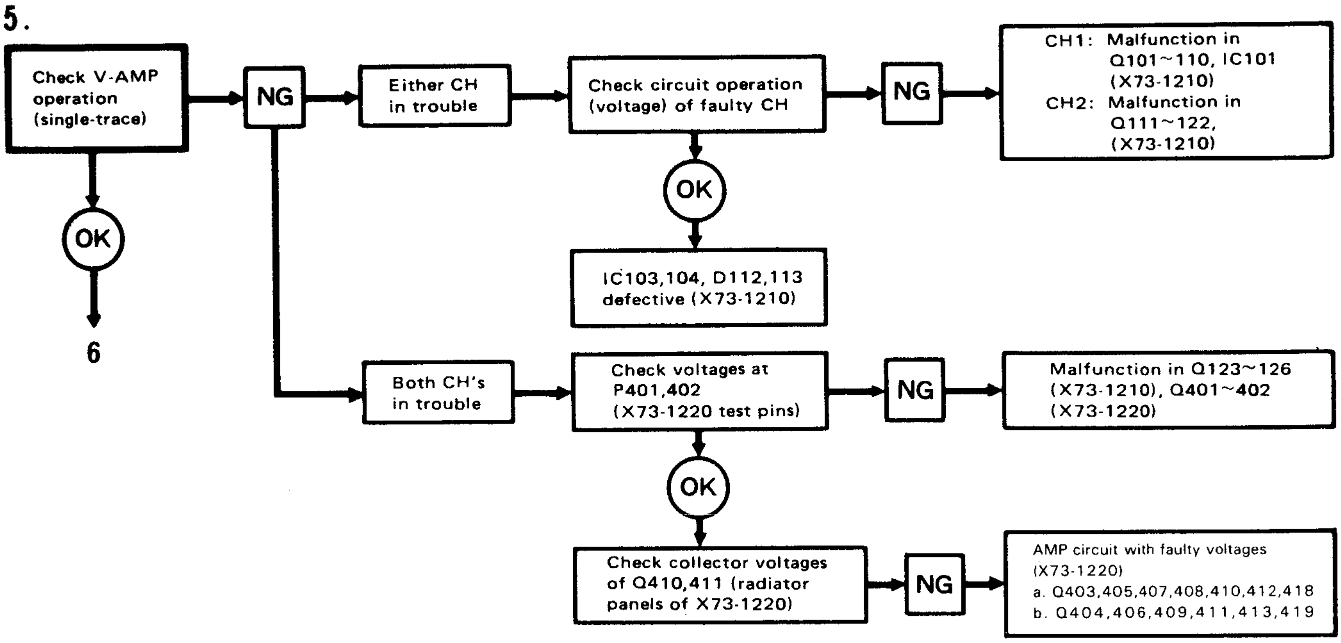

Check the trace (with TRIG LEVEL knob set to PULL AUTO)
NG
OK
5
Check collector wave form of Q11 (X74)
(See Fig.20)
NG
Sweep circuit malfunction (in X74, Q6~11, 25, IC1~3)
OK
Check X-Y voltage of IC1, No. 6 pin (3.5V, X74)
NG
IC1 detective (X74)
OK
Q18 malfunction (X74)

Fig. 20 Wave Form in SWEEP Circuit (X74-1190-01) (Input Signal 2 kHz Sine Wave, SWEEP TIME 0.1 mS/div)

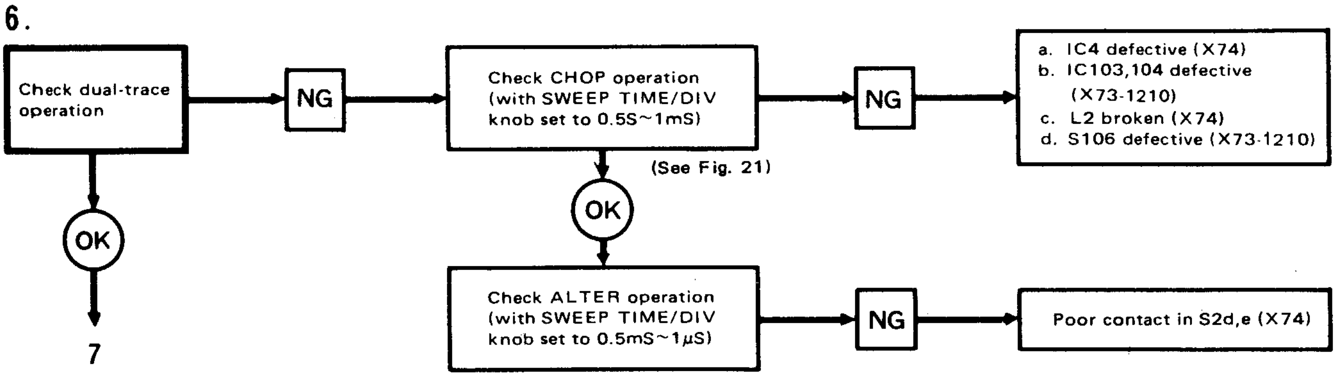


TROUBLESHOOTING

5.


Check V-AMP operation (single-trace)
NG
Either CH in trouble
Check circuit operation (voltage) of faulty CH
NG
CH1: Malfunction in Q101~110, IC101 (X73-1210)
CH2: Malfunction in Q111~122, (X73-1210)
OK
IC103,104, D112,113 defective (X73-1210)
OK
6
Both CH's in trouble
Check voltages at P401,402 (X73-1220 test pins)
NG
Malfunction in Q123~126 (X73-1210), Q401~402 (X73-1220)
OK
Check collector voltages of Q410,411 (radiator panels of X73-1220)
NG
AMP circuit with faulty voltages (X73-1220)
a. Q403,405,407,408,410,412,418
b. Q404,406,409,411,413,419

6.


Check dual-trace operation
NG
Check CHOP operation (with SWEEP TIME/DIV knob set to 0.5S~1mS)
NG
a. IC4 defective (X74)
b. IC103,104 defective (X73-1210)
c. L2 broken (X74)
d. S106 defective (X73-1210)
(See Fig. 21)
OK
Check ALTER operation (with SWEEP TIME/DIV knob set to 0.5mS~1μS)
NG
Poor contact in S2d,e (X74)
OK
7

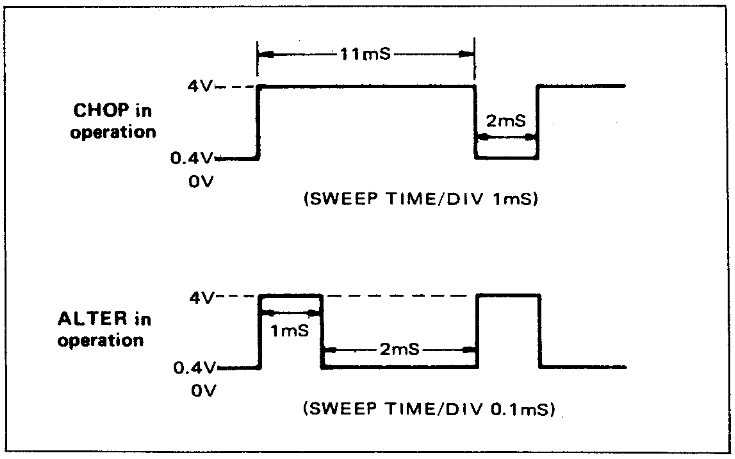
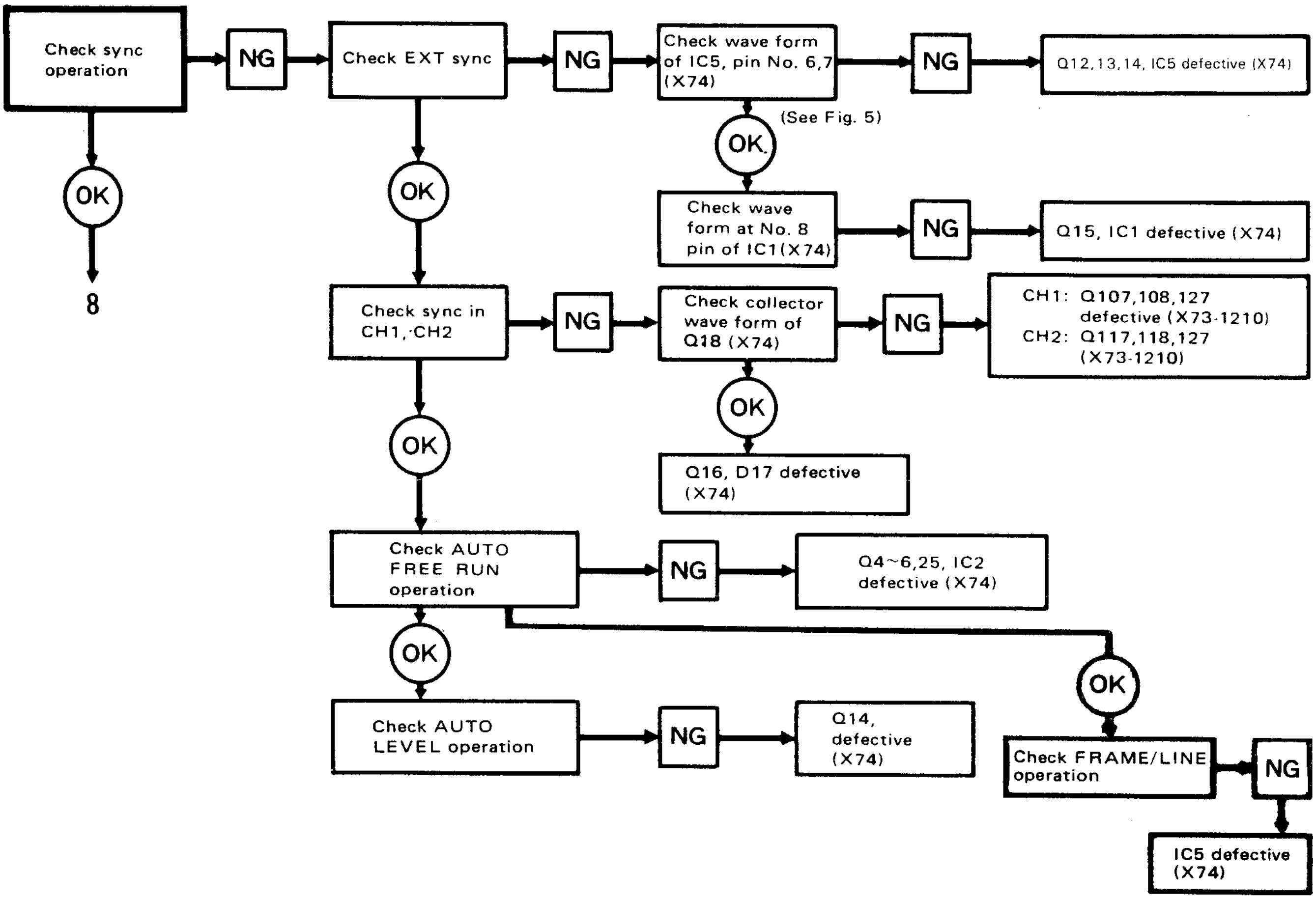

CHOP in operation
11mS
4V
2mS
0.4V
0V
(SWEEP TIME/DIV 1mS)
ALTER in operation
4V
1mS
2mS
0.4V
0V
(SWEEP TIME/DIV 0.1mS)

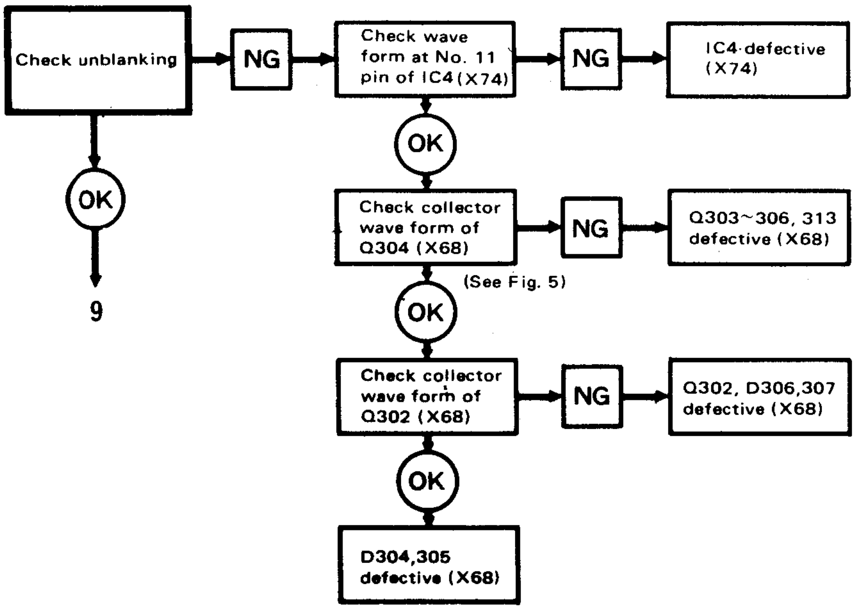
Fig. 21 J1 Clock Pulse Wave Forms at Terminal 5

TROUBLESHOOTING

7.

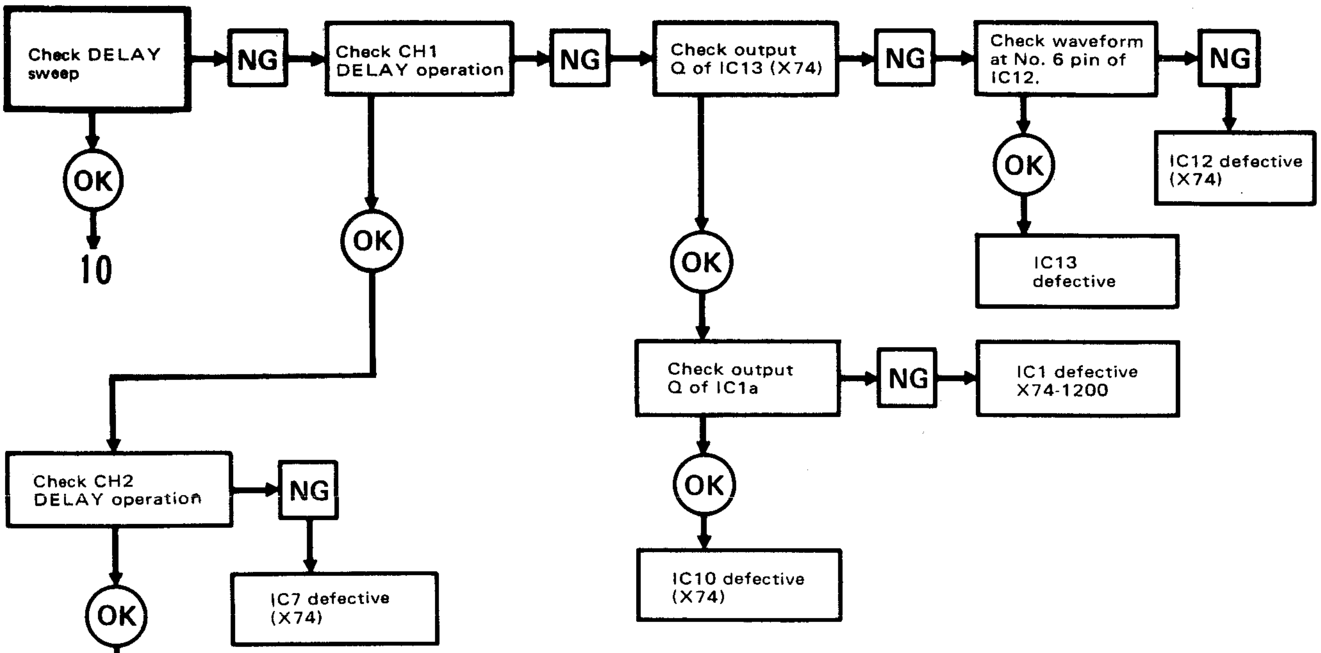

Check sync operation
NG
Check EXT sync
NG
Check wave form of IC5, pin No. 6,7 (X74)
NG
Q12,13,14, IC5 defective (X74)
(See Fig. 5)
OK
Check wave form at No. 8 pin of IC1(X74)
NG
Q15, IC1 defective (X74)
OK
8
OK
Check sync in CH1, CH2
NG
Check collector wave form of Q18 (X74)
NG
CH1: Q107,108,127 defective (X73-1210)
CH2: Q117,118,127 (X73-1210)
OK
Q16, D17 defective (X74)
OK
Check AUTO FREE RUN operation
NG
Q4~6,25, IC2 defective (X74)
OK
Check AUTO LEVEL operation
NG
Q14, defective (X74)
OK
Check FRAME/LINE operation
NG
IC5 defective (X74)

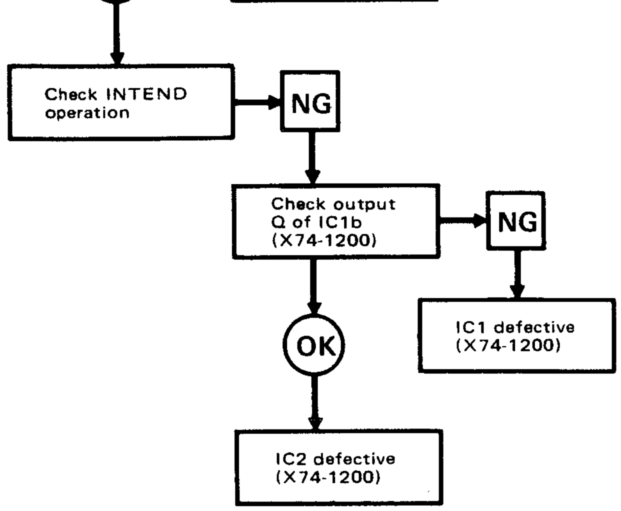
8.

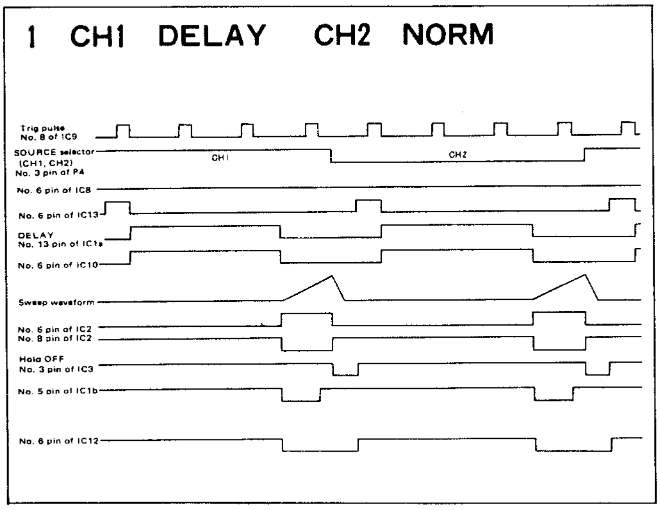

Check unblanking
NG
Check wave form at No. 11 pin of IC4(X74)
NG
IC4 defective (X74)
OK
9
OK
Check collector wave form of Q304 (X68)
NG
Q303~306, 313 defective (X68)
(See Fig. 5)
OK
Check collector wave form of Q302 (X68)
NG
Q302, D306,307 defective (X68)
OK
D304,305 defective (X68)

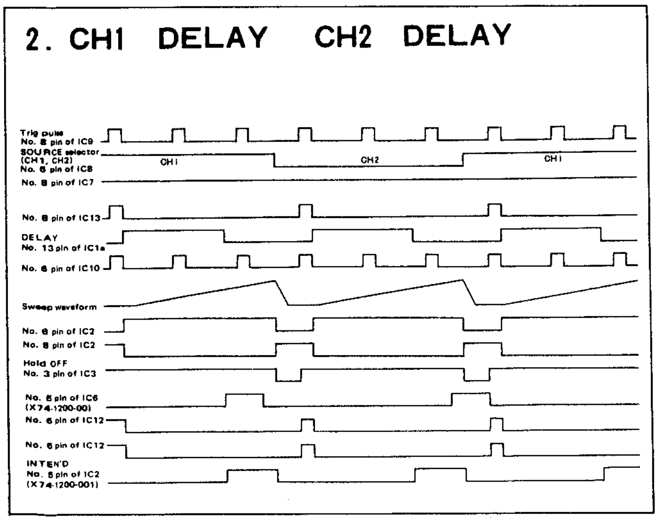
TROUBLESHOOTING

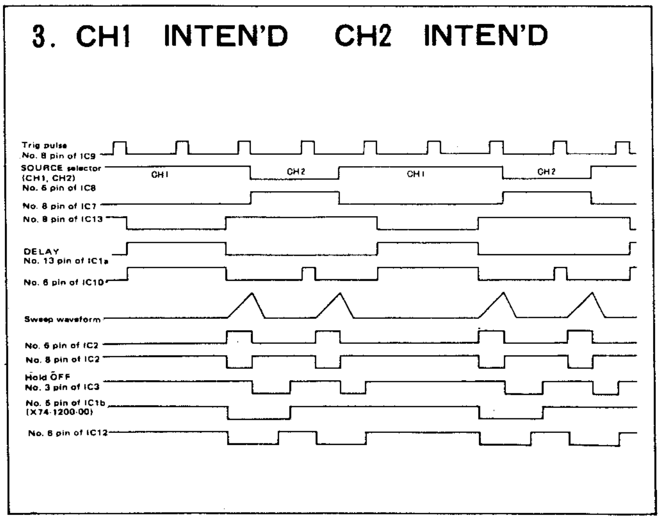
9.


Check DELAY sweep
NG
OK
10
Check CH1 DELAY operation
NG
OK
Check output Q of IC13 (X74)
NG
OK
Check waveform at No. 6 pin of IC12.
NG
OK
IC12 defective (X74)
IC13 defective
Check output Q of IC1a
NG
IC1 defective X74-1200
OK
IC10 defective (X74)
Check CH2 DELAY operation
NG
IC7 defective (X74)
OK


Check INTEND operation
NG
Check output Q of IC1b (X74-1200)
NG
IC1 defective (X74-1200)
OK
IC2 defective (X74-1200)

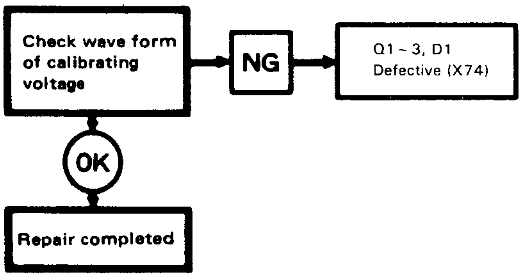

1 CH1 DELAY CH2 NORM
Trig pulse No. 8 of IC9
SOURCE selector (CH1, CH2) No. 3 pin of P4
CH1
CH2
No. 6 pin of IC8
No. 6 pin of IC13
DELAY No. 13 pin of IC1a
No. 6 pin of IC10
Sweep waveform
No. 6 pin of IC2
No. 8 pin of IC2
Hold OFF No. 3 pin of IC3
No. 5 pin of IC1b
No. 6 pin of IC12


2. CH1 DELAY CH2 DELAY
Trig pulse No. 8 pin of IC9
SOURCE selector (CH1, CH2) No. 6 pin of IC8
CH1
CH2
CH1
No. 8 pin of IC7
No. 8 pin of IC13
DELAY No. 13 pin of IC1a
No. 6 pin of IC10
Sweep waveform
No. 6 pin of IC2
No. 8 pin of IC2
Hold OFF No. 3 pin of IC3
No. 8 pin of IC6 (X74-1200-00)
No. 6 pin of IC12
No. 6 pin of IC12
INTEN'D No. 5 pin of IC2 (X74-1200-00)


3. CH1 INTEN'D CH2 INTEN'D
Trig pulse No. 8 pin of IC9
SOURCE selector (CH1, CH2) No. 6 pin of IC8
CH1
CH2
CH1
CH2
No. 8 pin of IC7
No. 8 pin of IC13
DELAY No. 13 pin of IC1a
No. 6 pin of IC10
Sweep waveform
No. 6 pin of IC2
No. 8 pin of IC2
Hold OFF No. 3 pin of IC3
No. 5 pin of IC1b (X74-1200-00)
No. 8 pin of IC12

TROUBLESHOOTING

10.


Check wave form of calibrating voltage
NG
Q1 ~ 3, D1 Defective (X74)
OK
Repair completed

PARTS LIST

MAIN CHASSIS

Fig. & index	Parts No.	Description
1	A01-0829-03	Case (Top)
2	A01-0835-13	Case (Bottom)
3	A13-0724-23	Frame
4	A20-2749-32	Die casting panel
5	A21-1001-02	Decorative panel
6	A23-1621-22	Rear panel
7	B07-0703-04	Push escutcheon (round, grey) x 2
8	B07-0708-04	Push escutcheon (rectangular, grey)
9	B07-0706-04	Push escutcheon (rectangular, light grey)
10	B07-0752-12	Rear escutcheon
11	B19-0708-04	Filter
12	B30-0919-15	Lamp ass'y
13	B30-0902-05	LED
14	E01-1403-05	CRT socket
15	E03-0201-05	Power connector
16	E04-0251-05	BNC receptacle
17	E21-0654-04	CAL terminal
18	E21-0657-04	Metal terminal
19	F07-0908-14	Grip cover
20	F10-1545-13	Shield plate
21	F10-1540-04	Shield plate
22	F10-1543-04	Shield plate
23	F11-0942-03	CRT shield
24	F15-0713-14	Felt
25	G02-0603-14	Spring
26	G13-0705-04	CRT mounting rubber
27	J10-0094-03	Bezel ass'y
28	J10-0072-02	Bezel
29	B07-0707-03	Bezel frame
30	J13-0033-15	Fuse holder
31	J19-1618-04	CRT band
32	J19-1619-04	CRT band
33	J21-2812-34	P.C.B. bracket
34	J21-2813-34	P.C.B. bracket
35	J21-2814-53	P.C.B. bracket
36	J21-2815-34	P.C.B. bracket
37	J21-2818-54	P.C.B. bracket
38	J21-2891-14	VR bracket
39	J21-2875-15	Gear
40	J21-2876-05	Ring
41	J21-2899-13	CRT Bracket
42	J32-0822-04	Hex. post
43	K01-0507-05	Handle
44	K21-0819-03	Knob
45	K21-0820-04	Knob
46	K21-0822-14	Knob
47	K27-0525-04	Lever knob (black)
48	K27-0526-04	Lever knob (dark grey)
49	K27-0507-04	Push knob (rectangular, grey)
50	K27-0504-04	Push knob (rectangular, light grey)
51	K27-0505-04	Push knob (rectangular, blue)
52		CRT 140CGB31
53	L01-9186-05	Power transformer
54	L39-0509-05	Rotator coil
55	R01-2012-05	Variable res. 5kΩB
56	R01-3027-05	Variable res. 10kΩB
57	R01-8502-05	Variable res. 1MΩB
58	R01-6003-05	Variable res. 250kΩB
59	R03-0503-05	Variable res. 500ΩB
60	R05-8502-05	Variable res. 2MΩB
61	S42-4507-05	Push switch
62	N08-0606-05	Hex. socket head screw
63	W01-0503-04	Cord wrap
64	X73-1210-02	Vertical amplifier unit
65	X73-1220-05	Vertical output unit
66	X74-1190-01	Horizontal sweep unit
67	X74-1200-00	Delay sweep unit
68	X68-1270-02	Power supply unit
69	X77-1020-00	Voltage selector unit
70	S37-2005-05	Lever switch
71	F11-0910-13	Shield case
72	S32-4007-05	Lever switch
73	R01-0501-05	Variable res. 300ΩB
74	F11-0147-24	Shield case
75	S03-3501-05	Rotary switch
76	R01-1505-05	Variable res. 1kΩB
77	S40-2502-05	Push switch
78	R01-4024-05	Variable res. 50kΩB
79	S29-2504-05	Rotary switch
80	R01-4024-05	Variable res. 50kΩB
81	S33-2501-05	Lever switch
82	S37-2005-05	Lever switch
83	S32-2013-05	Lever switch
84	F10-1510-04	Shield plate
85	F11-0911-33	Shield case
86	J21-2892-04	P.C.B. bracket
	B40-0765-14	Name plate (serial No.)
	B41-0701-14	Voltage indication sheet
	B50-2954-00	Instruction manual
	B40-2799-03	Name plate (CS-1820)
	E23-0505-04	Earth plate
	E23-0520-05	Earth lug
	E23-0513-05	Solder lug
	E31-0713-05	Lead wire/connector 2P
	E30-1818-05	JIS cord
(J-2)	E31-2226-05	Lead wire/connector 4P
(J-1)	E31-0723-05	Lead wire/connector 1P
(J-4)	E31-0689-05	Lead wire/connector 2P
(J-7)	E31-0687-05	Lead wire/connector 4P
(J-8)	E31-0686-05	Lead wire/connector 7P
(J-10)	E31-0660-05	Lead wire/connector 1P
(J-11)	E31-0659-05	Lead wire/connector 3P
(J-13)	E31-0690-05	Lead wire/connector
(J-14)	E31-0533-05	Lead wire/connector 1P
(J-15)	E31-0511-05	Lead wire/connector 4P
(J-16)	E31-0664-05	Lead wire/connector 3P
(J-18)	E31-0554-25	Lead wire/connector 3P
	E31-0680-15	Lead wire/connector
(J-20)	E31-0532-05	Lead wire/connector 1P
(J-21)	E31-0691-05	Lead wire/connector 1P
(J-22)	E31-0693-05	Lead wire/connector 2P
(J-19)	E31-0784-05	Lead wire/connector 4P
	E31-0717-05	Lead wire/connector
	F05-7011-05	Fuse 0.7A
	F05-3011-05	Fuse 0.3A
	F20-0618-04	Insulation sheet
	J02-0089-05	Rubber leg
(L201, 202)	L40-1091-41	Ferri inductor
(R206, 207)	RD14BB2E151J	Carbon res. 150Ω ±5% 1/4W
(R203, 204)	RD14BB2E220J	Carbon res. 22Ω ±5% 1/4W
(R205)	RD14BB2E154J	Carbon res. 150kΩ ±5% 1/4W
	H01-2948-04	Carton box
	H10-2807-02	Pad (foamed styrene)
	H12-0522-04	Pad (carton)
	H20-1701-24	Protection cover
	H25-0029-04	Polyethylene bag

VERTICAL AMPLIFIER (X73-1210-02)

Ref. No.	Parts No.	Description
RESISTOR		
R101	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R102	RN14BK2H9003F	Metal film 900kΩ ±1% 1/2W
R103	RN14BK2E1113F	Metal film 111kΩ ±1% 1/4W
R104	RN14BK2H9903F	Metal film 990kΩ ±1% 1/2W
R105	RN14BK2E1012F	Metal film 10.1kΩ ±1% 1/4W
R106	RN14BK2E4021F	Metal film 4.02kΩ ±1% 1/4W

PARTS LIST

Ref. No.	Parts No.	Description			
R107	RN14BK2H1004F	Metal film	1MΩ	±1%	1/2W
R108	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R109~111	RD14CB2E220J	Carbon	22Ω	±5%	1/4W
R112	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R113~116	RD14CB2E220J	Carbon	22Ω	±5%	1/4W
R117,118	RN14BK2E3901F	Metal film	3.9kΩ	±1%	1/4W
R119	RD14CB2E681J	Carbon	680Ω	±5%	1/4W
R120	RN14BK2E2701F	Metal film	2.7kΩ	±1%	1/4W
R121	RN14BK2E3301F	Metal film	3.3kΩ	±1%	1/4W
R122	RN14BK2E2201F	Metal film	2.2kΩ	±1%	1/4W
R123	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R124	RN14BK2E1300F	Metal film	130Ω	±1%	1/4W
R126	RN14BK2E69R8F	Metal film	69.8Ω	±1%	1/4W
R127~129	RN14BK2E1000F	Metal film	100Ω	±1%	1/4W
R130	RN14BK2E10R0F	Metal film	10Ω	±1%	1/4W
R131, R132	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R133,134	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R135	RN14BK2E1500F	Metal film	150Ω	±1%	1/4W
R136	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R137,138	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R139,140	RN14BK2E3901F	Metal film	3.9kΩ	±1%	1/4W
R141	RN14BK2E1200F	Metal film	120Ω	±1%	1/4W
R142,143	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R144,145	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R146~149	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R150	RD14BB2E560J	Carbon	56Ω	±5%	1/4W
R151	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R152	RD14BB1E222J	Carbon	2.2kΩ	±5%	1/4W
R153,154	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R155,156	RN14BK2E5600F	Metal film	560Ω	±1%	1/4W
R157	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R158	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R159	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R160,161	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R162	RN14BK2H9003F	Metal film	900kΩ	±1%	1/2W
R163	RN14BK2E1113F	Metal film	111kΩ	±1%	1/4W
R164	RN14BK2H9903F	Metal film	990kΩ	±1%	1/2W
R165	RN14BK2E1012F	Metal film	10.1kΩ	±1%	1/4W
R166	RN14BK2E4021F	Metal film	4.02kΩ	±1%	1/4W
R167	RN14BK2H1004F	Metal film	1MΩ	±1%	1/2W
R168	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R169~176	RD14CB2E220J	Carbon	22Ω	±5%	1/4W
R177,178	RN14BK2E3901F	Metal film	3.9Ω	±1%	1/4W
R179	RD14CB2E681J	Carbon	680Ω	±5%	1/4W
R180	RN14BK2E2701F	Metal film	2.7kΩ	±1%	1/4W
R181	RN14BK2E3301F	Metal film	3.3kΩ	±1%	1/4W
R182	RN14BK2E2201F	Metal film	2.2kΩ	±1%	1/4W
R183	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R184	RN14BK2E1300F	Metal film	130Ω	±1%	1/4W
R186	RN14BK2E69R8F	Metal film	69.8Ω	±1%	1/4W
R187~189	RN14BK2E1000F	Metal film	100Ω	±1%	1/4W
R190	RN14BK2E10R0F	Metal film	10Ω	±1%	1/4W
R191, R192	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R193,194	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R195	RN14BK2E1500F	Metal film	150Ω	±1%	1/4W
R196	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R197,198	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R199,200	RN14BK2E3901F	Metal film	3.9kΩ	±5%	1/4W
R201	RD14BB2E820J	Carbon	82Ω	±5%	1/4W
R202,203	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R204,205	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R206~209	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R210	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R211,212	RD14BB2E392J	Carbon	3.9kΩ	±5%	1/4W
R213,214	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R215,216	RN14BK2E5600F	Metal film	560Ω	±1%	1/4W
R217,218	RD14BB2E391J	Carbon	390Ω	±5%	1/4W
R219,220	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R221	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R222	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R223	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R224,225	RN14BK2E2700F	Metal film	270Ω	±1%	1/4W
R226,227	RN14BK2E91R0F	Metal film	91Ω	±1%	1/4W
R228	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R229,230	RN14BK2E2201F	Metal film	2.2kΩ	±1%	1/4W
R232	RD14BB2E680J	Carbon	68Ω	±5%	1/4W
R233,234	RN14BK2E2001F	Metal film	2kΩ	±1%	1/4W
R235	RD14BB2E680J	Carbon	68Ω	±5%	1/4W
R239,240	RN14BK2H9963F	Metal film	996kΩ	±1%	1/2W
R241,242	RN14BK2E53R6F	Metal film	53.6Ω	±1%	1/4W
R243	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R244	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R245~248	RN14BK2E10R0F	Metal film	10Ω	±1%	1/4W
R249,250	RD14BB2E5R6J	Carbon	5.6Ω	±5%	1/4W
VR101	R12-0527-05	Semi-fixed	330ΩB		
VR102	R01-0501-05	Variable with "VARI" switch	300ΩB		
VR103	R12-0501-05	Semi-fixed	100ΩB		
VR104	R01-1505-05	Variable with "POSITION" switch	1kΩB		
VR105	R12-1003-05	Semi-fixed	2.2kΩB		
VR106	R12-0527-05	Semi-fixed	330ΩB		
VR107	R01-0501-05	Variable with "VARI" switch	300ΩB		
VR108	R12-0501-05	Semi-fixed	100ΩB		
VR109	R01-1505-05	Variable with "POSITION" switch	1kΩB		
VR110,111	R12-0502-05	Semi-fixed	100ΩB		
VR112	R12-1003-05	Semi-fixed	2.2kΩB		
VR113	R12-2020-05	Semi-fixed	6.8kΩB		
VR117,118	R12-0502-05	Semi fixed	100ΩB		
CAPACITOR					
C101	C91-0501-05	Metalized film	0.047μF	±10%	630WV
C103	CM93BD2A470J	Mica	47pF	±5%	100WV
C104	CC45CH2H020C	Ceramic	2pF	±0.25pF	500WV
C105	CM93BD2A151J	Mica	150pF	±5%	100WV
C106	C91-0502-05	Metalized film	0.01μF	±10%	630WV
C107,108	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C110,112	CE04W1A101	Electrolytic	100μF		10WV
C114	C91-0501-05	Metalized film	0.047μF	±10%	630WV
C115	C91-0502-05	Metalized film	0.01μF	±10%	630WV
C117	CM93BD2A470J	Mica	47pF	±5%	100WV
C118	CC45CH2H020C	Ceramic	2pF	±0.25pF	500WV
C119	CM93BD2A151J	Mica	150pF	±5%	100WV
C120~122	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C123	CE04W1A101	Electrolytic	100μF		10WV
C125,126	CE04W1A101	Electrolytic	100μF		10WV
C127	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C128	CE04W1C221	Electrolytic	220μF		16WV
C129,130	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C131	CE04W1A101	Electrolytic	100μF		10WV
C132	CC45CH1H150J	Ceramic	15pF	±5%	50WV
C133	CC45CH1H220J	Ceramic	22pF	±5%	50WV
C135	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C136	CC45CH1H121J	Ceramic	120pF	±5%	50WV
C137	CC45CH1H150J	Ceramic	15pF	±5%	50WV
C138	CC45CH1H220J	Ceramic	22pF	±5%	50WV
C140	CC45CH1H050C	Ceramic	5pF	±0.25pF	50WV
C141	CC45CH1H121J	Ceramic	120pF	±5%	50WV
C142,143	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C144	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	
				−20%	12WV
C146	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C147	C90-0298-05	Ceramic, semi-conductor			
			0.1μF	+80%	

PARTS LIST

Ref. No.	Parts No.	Description
		−20% 12WV
C148	CM93BD2A331J	Mica 330pF ±5% 100WV
C149,150	CC45CH2H020C	Ceramic 2pF ±0.25pF 500WV
C151	CM93BD2A331J	Mica 330pF ±5% 100WV
C154	CC45CH1H220J	Ceramic 22pF ±5% 50WV
C155	CC45CH1H150J	Ceramic 15pF ±5% 50WV
C156~159	CC45CH1H100D	Ceramic 10pF ±0.5pF 50WV
C160,161	CC45CH1H330J	Ceramic 33pF ±5% 50WV
TC101	C05-0065-05	Ceramic trimmer 6pF
TC102	C05-0066-05	Ceramic trimmer 10pF
TC103	C05-0065-05	Ceramic trimmer 6pF
TC104	C05-0066-05	Ceramic trimmer 10pF
TC105,106	C05-0065-05	Ceramic trimmer 6pF
TC107	C05-0066-05	Ceramic trimmer 10pF
TC108	C05-0065-05	Ceramic trimmer 6pF
TC109	C05-0066-05	Ceramic trimmer 10pF
TC110	C05-0065-05	Ceramic trimmer 6pF
TC111,112	C05-0066-05	Ceramic trimmer 10pF
TC113	C05-0401-05	Ceramic trimmer 20pF
SEMICONDUCTOR		
D101~108		Diode, silicon, small signal 1S1587
D109, 111~114 116,117 119~121		Diode, silicon, small signal 1S1555
D122,123		Diode, silicon, small signal 1S1587
D124~127		Diode, germanium 1N60
Q101		FET 2SK30A(O)
Q102		Dual FET 2SK228T-2 & 3
Q103~106		Transistor, NPN silicon 2SC535(B)
Q107,108		Transistor, PNP silicon 2SA838(C)
Q109,110		Transistor, NPN silicon 2SC535(B)
Q111		FET 2SK30A(O)
Q112		Dual FET 2SK228T-2 & 3
Q113~116		Transistor, NPN silicon 2SC535(B)
Q117,118		Transistor, PNP silicon 2SA838(C)
Q119~122		Transistor, NPN silicon 2SC535(B)
Q123,124		Transistor, PNP silicon 2SA844(D)
Q125,126		Transistor, NPN silicon 2SC458(C)
Q127		Transistor, PNP silicon 2SA844(D)
IC101,102		IC, Linear HA1127
IC103		IC, Digital SN7400N
IC104		IC, Digital SN7472N
MISCELLANEOUS		
—	E29-0503-05	Terminal x 2 (Fluorine)
—	E29-0504-05	Terminal x 10 (Fluorine)
J5	E31-0658-05	Lead wire with connector
P101	E40-0802-05	Connector 8P
P102	E40-0701-05	Connector 7P
—	F10-1510-04	Shield plate
—	F11-0147-24	Shield case
—	F11-0910-13	Shield case
—	J25-2886-13	Printed circuit board
L101,102	L40-2201-03	Ferri inductor 22μH
TH101,102		Thermister SDT-100
—	R92-0150-05	Jumper wire, resistor type
S101,102	S32-4007-05	Lever switch
S103,104	S03-3501-05	Rotary switch
S105	S40-2502-05	Pushbutton switch
S106	S37-2005-05	Lever switch

VERTICAL OUTPUT AMPLIFIER (X73-1220-05)

Ref. No.	Parts No.	Description
RESISTOR		
R401,402	RN14BK2E91R0F	Metal film 91Ω ±1% 1/4W
R403,404	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R405	RD14BB2E221J	Carbon 220Ω ±5% 1/4W
R406,407	RD14BB2E222J	Carbon 2.2kΩ ±5% 1/4W
R408	RD14BB2E221J	Carbon 220Ω ±5% 1/4W
R409,410	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R411	RD14BB2E100J	Carbon 10Ω ±5% 1/4W
R412,413	RD14BB2E391J	Carbon 390Ω ±5% 1/4W
R414~417	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R418,419	RD14BB2E222J	Carbon 2.2kΩ ±5% 1/4W
R420,421	RD14BB2E152J	Carbon 1.5kΩ ±5% 1/4W
R422,423	RN14BK2E4701F	Metal film 4.7kΩ ±1% 1/4W
R424,425	RD14BB2E1R5J	Carbon 1.5Ω ±5% 1/4W
R426,427	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R428,429	RN14BK2E7502F	Metal film 75kΩ ±1% 1/4W
R430,431	RD14BB2E101J	Carbon 100Ω ±5% 1/4W
R432,433	RD14BB2E100J	Carbon 10Ω ±5% 1/4W
R444~447	RD14BB2E101J	Carbon 100Ω ±5% 1/4W
R448,449	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R450,451	RD14BB2E222J	Carbon 2.2Ω ±5% 1/4W
R452	RD14BB2E681J	Carbon 680Ω ±5% 1/4W
R453	RD14BB2E181J	Carbon 180Ω ±5% 1/4W
R454	RD14BB2E101J	Carbon 100Ω ±5% 1/4W
R456	RD14BB2E681J	Carbon 680Ω ±5% 1/4W
R457	RD14BB2E393J	Carbon 33kΩ ±5% 1/4W
R458	RD14BB2E152J	Carbon 1.5kΩ ±5% 1/4W
R459,460	RD14BB2E393J	Carbon 39kΩ ±5% 1/4W
R461	RD14BB2E333J	Carbon 33kΩ ±5% 1/4W
R463	RD14BB2E220J	Carbon 22Ω ±5% 1/4W
R466	RD14BB2E102J	Carbon 1kΩ ±5% 1/4W
R467	RD14BB2E513J	Carbon 51kΩ ±5% 1/4W
R471,472	RD14BB2E470J	Carbon 47Ω ±5% 1/4W
R476	RD14BB2E112J	Carbon 1.1kΩ ±5% 1/4W
R477,478	RD14BB2E181J	Carbon 180Ω ±5% 1/4W
VR401	R12-0511-05	Semi-fixed 220ΩB
VR402	R12-3004-05	Semi-fixed 47kΩB
VR404	R12-5018-05	Semi-fixed 220kΩB
VR405	R12-1002-05	Semi-fixed 1kΩB
CAPACITOR		
C401,402	C90-0298-05	Ceramic semi-conductor 0.1μF +80% −20% 12WV
C403	CE04W1A331M	Electrolitic 330μF 10WV
C407	CK45D1H222M	Ceramic 2200pF ±20% 50WV
C408	CK45D1H103M	Ceramic 0.01μF ±20% 50WV
C409	CC45CH1H100D	Ceramic 10pF ±0.5pF 50WV
C410	CC45CH1H150J	Ceramic 15pF ±5% 50WV
C411	CE04W1E221	Electrolytic 220μF 25WV
C412	CE04W1C101	Electrolytic 100μF 16WV
C413	C90-0298-05	Ceramic semi-conductor 0.1μF +80% −20% 12WV
C414	CE04W1C470	Electrolytic 47μF 16WV
C415	CK45D1H103M	Ceramic 0.01μF ±20% 50WV
C416	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C417,418	CC45CH2H010C	Ceramic 1pF ±0.25pF 500WV
C423,424	CC45SL1H121J	Ceramic 120pF ±5% 50WV
C428,429	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C430	C90-0298-05	Ceramic semi-conductor 0.1μF +80% −20% 12WV
C431	CK45D1H103M	Ceramic 0.01μF ±20% 50WV
C432	C90-0298-05	Ceramic semi-conductor 0.1μF +80% −20% 12WV
C433	CE04W1A101	Electrolytic 100μF 10WV
C434	CE04W1E221	Electrolytic 220μF 25WV
C435	C90-0298-05	Ceramic semi-conductor 0.1μF +80% −20% 12WV

PARTS LIST

Ref. No.	Parts No.	Description			
C437	CC45SL1H820J	Ceramic	82pF	±5%	50WV
C439	CC45SL1H221J	Ceramic	220pF	±5%	50WV
C443,444	CK45B2H102K	Ceramic	1000pF	±10%	500WV
TC402,403	C05-0066-05	Ceramic trimmer	10pF		
		SEMICONDUCTOR			
D401,402		Diode, silicon	1S1587		
D403		Diode, zener	WZ-130		
D404		Diode, zener	WZ-050		
D405,406		Diode, silicon	1S1555		
D407		Diode, zener	WZ-050		
D408,409		Diode, silicon	1S1587		
Q401 ~ Q404		Transistor, NPN silicon	2SC535-(B)		
Q405 ~ 409		Transistor, NPN silicon	2SC458-(C)		
Q410,411		Transistor, NPN silicon	2SC1628-(Y)		
Q412,413		Transistor, PNP silicon	2SA818-(Y)		
Q418,419		Transistor, NPN silicon	2SC458-(C)		
		MISCELLANEOUS			
—	E23-0047-04	Terminal			
J401,402	E40-0806-05	Connector			
—	F01-0821-04	Heat sink x 2			
—	J32-0122-04	Hexagon boss x 2			
—	J21-2892-04	Bracket (P.C. board)			
—	J25-2808-34	Printed circuit board			
L401	L40-4701-03	Ferri-inductor	47μH		
L406	L40-2201-03	Ferri-inductor	22μH		
TH401 ~ 403		Thermistor	SDT-100		

SWEEP (X74-1190-01)

Ref. No.	Parts No.	Description			
		RESISTOR			
R1	RD14BB2E562J	Carbon	5.6kΩ	±5%	1/4W
R2	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R3	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R4	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R5	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R6,7	RD14BB2E563J	Carbon	56kΩ	±5%	1/4W
R8	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R9	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R11	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R12	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R13	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R14	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R15	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R16,17	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R18	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R19	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R20	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R21	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R22	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R23	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R25	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R26	RN14BK2E1003F	Metal film	100kΩ	±1%	1/4W
R27	R92-0709-05	Metal film	3MΩ	±1%	1/4W
R28	RN14BK2E1003F	Metal film	100kΩ	±1%	1/4W
R29	RN14BK2E3003F	Metal film	300kΩ	±1%	1/4W
R30	RN14BK2H5003F	Metal film	500kΩ	±1%	1/2W
R31	RN14BK2H1004F	Metal film	100kΩ	±1%	1/2W
R32	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R33	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R34	RD14BB2E683J	Carbon	68kΩ	±5%	1/4W
R35	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R36	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R37	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R38	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R39	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R40	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R41	RD14BB2E153J	Carbon	15kΩ	±5%	1/4W
R42	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R43	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R44	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R45	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R46	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R47	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R48	RD14BB2E185J	Carbon	1.8MΩ	±5%	1/4W
R49	RD14BB2E224J	Carbon	220kΩ	±5%	1/4W
R50 ~ 52	RD14BB2E104J	Carbon	100kΩ	± 5%	1/4W
R53	RD14BB2E205J	Carbon	2MΩ	±5%	1/4W
R55	RD14BB2E123J	Carbon	12kΩ	±5%	1/4W
R56	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R57	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R58	RD14BB2E391J	Carbon	390Ω	±5%	1/4W
R59	RD14BB2E220J	Carbon	22Ω	±5%	1/4W
R60	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R61	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R63	RD14BB2E153J	Carbon	15kΩ	±5%	1/4W
R66	RD14BB2E563J	Carbon	56kΩ	±5%	1/4W
R67	RD14BB2E683J	Carbon	68kΩ	±5%	1/4W
R70	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R71	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R72	RD14BB2E123J	Carbon	12kΩ	±5%	1/4W
R73	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R74	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R75	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R76	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R77	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R78	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R79	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R80	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R81	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R82	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R83 ~ 85	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R86	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R87	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R88	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R89,90	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R91	RS14GB3D472G	Metal oxide film	4.7kΩ	±2%	2W
R92	RS14GB3D512G	Metal oxide film	5.1kΩ	±2%	2W
R93	RS14GB3A393J	Metal oxide film	39kΩ	±5%	1W
R94,95	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R96	RD14BB2E821J	Carbon	820Ω	±5%	1/4W
R97	RD14BB2E183J	Carbon	18kΩ	±5%	1/4W
R98	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R99	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R100	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R101	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R102	RD14BB2E182J	Carbon	1.8kΩ	±5%	1/4W
R103	RD14BB2E393J	Carbon	39kΩ	±5%	1/4W
R104	RD14BB2E562J	Carbon	5.6kΩ	±5%	1/4W
R105	RD14BB2E183J	Carbon	18kΩ	±5%	1/4W
R111	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R112	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R113	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R114	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R115,116	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R117,118	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R119	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R120	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R121	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R122	RD14BB2E183J	Carbon	18kΩ	±5%	1/4W
R123	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R124	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R131	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R138	RD14BB2E221J	Carbon	220Ω	±5%	1/4W

PARTS LIST

Ref. No.	Parts No.	Description			
R139,140	RN14BK2E4701F	Metal film	4.7kΩ	±1%	1/4W
R149	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R150	RD14BB2E392J	Carbon	3.9kΩ	±5%	1/4W
R152	RD14BB2E393J	Carbon	39kΩ	±5%	1/4W
R153	RD14BB2E183J	Carbon	18kΩ	±5%	1/4W
R154	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R157	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
VR1	R12-3041-05	Semi-fixed	10kΩB		
VR2,3	R12-5025-05	Semi-fixed	100kΩB		
VR4	R01-2501-05	Semi-fixed with switch (S2)	5kΩB		
VR5	R12-5025-05	Semi-fixed	100kΩB		
VR6	R12-1028-05	Semi-fixed	4.7kΩB		
VR7	R12-3042-05	Semi-fixed	47kΩB		
VR8	R01-4024-15	Variable with switch (S1)	50kΩB		
VR9	R12-8501-05	Semi-fixed	2.2MΩB		
VR10	R12-3041-05	Semi-fixed	0kΩB		
VR11	R12S-1029-05	Semi-fixed	1kΩB		
VR12	R12-2020-05	Semi-fixed	6.8kΩB		
VR13,14	R12-0502-05	Semi-fixed	100ΩB		
VR15	R12-3040-05	Semi-fixed	22kΩB		
VR17,18	R12S-1029-05	Semi-fixed	1kΩB		
VR19	R12-3507-05	Semi-fixed	15kΩB		
VR20	R12-1028-05	Semi-fixed	4.7kΩB		
CAPACITOR					
C1,2	CQ93M1H682K	Mylar	6800pF	±10%	50WV
C3	CE04W1A101	Electrolytic	100μF		10WV
C4～6	CE04W1H010	Electrolytic	1μF		50WV
C7,8	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C9	CC45CH1H330J	Ceramic	33pF	±5%	50WV
C10	C90-0320-05	Metalized film	0.47μF	±1%	
C11	C90-0321-05	Metalized film	0.0047μF	±1%	
C12	CC45CH1H330J	Ceramic	33pF	±5%	50WV
C13	CC45CH1H100D	Ceramic	10pF	±0.5pF	50WV
C14	CS15E1VR33M	Tuntaleum	0.33μF	±20%	35WV
C15	CQ93M1H333K	Mylar	0.033μF	±10%	50WV
C16	CK45D1H102M	Ceramic	1000pF	±20%	50WV
C17	C90-0298-05	Ceramic, semi-conductor	0.1μF	+80% −20%	12WV
C18	CC45CH1H180J	Ceramic	18pF	±5%	50WV
C19,20	CQ93M1H152K	Mylar	1500pF	±10%	50WV
C21	CK45B1H681K	Ceramic	680pF	±10%	50WV
C22	CC45SL1H151J	Ceramic	150pF	±5%	50WV
C23	CC45SL2H100D	Ceramic	10pF	±0.5pF	500WV
C24	CQ93M1H153K	Mylar	0.015μF	±10%	50WV
C25	CC45SL2H101J	Ceramic	100pF	±5%	500WV
C26	CC45SL1H150J	Ceramic	15pF	±5%	50WV
C27	CK45D2H332M	Ceramic	3300pF	±20%	50WV
C28,29	CE04BW1H010M	Electrolytic	1μF	±20%	50WV
C30	CC45SL1H150J	Ceramic	15pF	±5%	50WV
C31～34	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C35	CC45SL1H150J	Ceramic	15pF	±5%	50WV
C37	CC45CH1H050C	Ceramic	5pF	±0.25pF	50WV
C38	CK45D2H102M	Ceramic	1000pF	±20%	50WV
C39	CE04W1A101	Electrolytic	100μF		10WV
C40,41	CE04W1C471M	Electrolytic	470μF		16WV
C42	CK45D1H222M	Ceramic	2200pF	±20%	50WV
C43	CE04W1A470	Electrolytic	47μF		10WV
C44	C90-0298-05	Ceramic, semi-conductor	0.1μF	+80% −20%	12WV
C45	CC45SL1H470J	Ceramic	47pF	±5%	50WV
C46	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C48	CC45SL1H100D	Ceramic	10pF	±0.5pF	
C49	CC45SL1H221J	Ceramic	220pF	±5%	50WV
C51	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C52～56	C90-0298-05	Ceramic, semi-conductor	0.1μF	+80% −20%	12WV
C57	CC45SL1H221J	Ceramic	220pF	±5%	50WV

Ref. No.	Parts No.	Description			
C58	CC45SL1H050C	Ceramic	5pF	±0.5pF	50WV
C59	CC45SL1H221J	Ceramic	220pF	±5%	50WV
C60	C90-0298-05	Ceramic, semi-conductor	0.1μF	+80% −20%	12WV
C61,62	CC45SL1H020C	Ceramic	2pF	±0.25pF	50WV
C63	CE04BW1H010M	Electrolytic	1μF	±20%	50WV
C64	CE04W1A101	Electrolytic	100μF		10WV
C65	CQ93M1H222K	Mylar	2200pF	±10%	50WV
C78～80	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C81～84	C90-0298-05	Ceramic, semi-conductor	0.1μF	+80% −20%	12WV
C87	CE04W1A470	Electrolytic	47μF		10WV
C88	CE04W1A221	Electrolytic	220μF		10WV
C89	CC45SL1H151J	Ceramic	150pF	±5%	50WV
C90	CK45D1H152M	Ceramic	1500pF	±20%	50WV
C91	CC45SL1H471J	Ceramic	470pF	±5%	50WV
C92	CE04BW1H010M	Electrolytic	1μF	±20%	50WV
C93	CK45B1H471K	Ceramic	470pF	±10%	50WV
C94～96	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
TC1	C05-0405-05	Ceramic trimmer	20pF		
TC2	C05-0404-05	Ceramic trimmer	10pF		
TC3,4	C05-0403-05	Ceramic trimmer	6pF		
SEMICONDUCTOR					
Q1～6		Transistor, NPN silicon	2SC945(P)		
Q7,8		Transistor, PNP silicon	2SA733(Q)		
Q9		Transistor, NPN silicon	2SC945(P)		
Q10		FET	2SK30A(O)		
Q11		Transistor, NPN silicon	2SC945(P)		
Q12		FET	2SK30A(O)		
Q13		Transistor, NPN silicon	2SC945(P)		
Q14		FET	2SK185-2-M		
Q15		FET	2SK30A(O)		
Q16～19		Transistor, NPN silicon	2SC945(P)		
Q20		Transistor, NPN silicon	2SC535(C)		
Q21,22		Transistor, NPN silicon	2SC945(P)		
Q23,24		Transistor, NPN silicon	2SC1507		
Q25～29		Transistor, NPN silicon	2SC945(P)		
Q31		Transistor, NPN silicon	2SC945(P)		
IC1		IC, Digital	SN74H00N		
IC2		IC, Digital	SN74H72N		
IC3		IC, Digital	NJM555D		
IC4		IC, Digital	SN7400N		
IC5		IC, Digital	RC733T		
IC6～10		IC, Digital	SN74LS00N		
IC12		IC, Digital	SN74LS00N		
IC13		IC, Digital	SN74H72N		
D1		Diode, germanium	1N60		
D2～4		Diode, silicon	1S1555		
D5		Diode, germanium	1N60		
D6		Diode, silicon	1S1587		
D7～10		Diode, silicon	1S1555		
D11		Diode, germanium	1N60		
D15		Diode, silicon	1S1555		
D16		Diode, zener	YZ-030		
D17～20		Diode, silicon	1S1555		
D22,23		Diode, silicon	1S1555		
D26		Diode, silicon	1S1555		
D28,29		Diode, silicon	1S1555		
D30		Diode, germanium	1N60		
D32～40		Diode, silicon	1S1555		
MISCELLANEOUS					
	E23-0046-04	Terminal x 10			
J1,2	E40-0808-05	Connector			

PARTS LIST

Ref. No.	Parts No.	Description	
P2	E40-0367-05	Connector 3P	
P3	E40-0767-05	Connector 7P	
P4	E40-0367-05	Connector 3P	
P5	E40-0467-05	Connector 4P	
P7	E40-0467-05	Connector 4P	
P8	E40-0267-05	Connector 2P	
L2	L40-4701-03	Ferri-inductor	47μH
L3	L40-3991-02	Ferri-inductor	3.9μH
L4,5	L40-1511-03	Ferri-inductor	150μH
L6 ~ 8	L40-4701-03	Ferri-inductor	47μH
L9	L40-1011-03	Ferri-inductor	100μH
L10	L40-3311-03	Ferri-inductor	330μH
L11	L40-1511-03	Ferri-inductor	150μH
–	J25-2866-23	Printed circuit board	
S2	S29-2504-05	Rotary switch	
S3	S33-2501-05	Lever switch	
S4	S37-2005-05	Lever switch	
S5	S32-2013-05	Lever switch	

DELAY SWEEP (X74-1200-00)

Ref. No.	Parts No.	Description			
RESISTOR					
R1	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R2	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R3	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R5	RD14BB2E224J	Carbon	220kΩ	±5%	1/4W
R6	RN14BK2E4701F	Metal film	4.7kΩ	±1%	1/4W
R7	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
VR1	R06-9501-05	Variable with switch (S01-1510-15) 100kΩ			
CAPACITORS					
C1	CE04W1A3R3	Electrolytic	3.3μF		10WV
C2	C91-0542-05	Filmed	0.33μF		
C3	CQ93M1H333K	Mylar	0.033μF	±10%	50WV
C4	CQ93M1H332K	Mylar	3300pF	±10%	50WV
C5	CC45SL1H221J	Ceramic	220pF	±5%	50WV
C6	CC45SL1H101J	Ceramic	100pF	±5%	50WV
C7	CE04W1A470	Electrolytic	47μF		10WV
C8	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
C9	CK45D1H103M	Ceramic	0.01μF	±20%	50WV
SEMICONDUCTORS					
IC1		IC, Digital	SN74LS123N		
IC2		IC, Digital	SN74H72N		
D1 ~ 4		Diode, silicon	1S1555		
MISCELLANEOUS					
–	E23-0047-04	Terminal			
–	F11-0943-04	Shield case			
–	J61-0053-05	Supporter, (PC board)			
–	J25-2867-14	Printed circuit board			
L1	L40-4701-03	Ferri-inductor 47μH			
P1	E40-0269-05	Connector, 2P			
P2	E40-0769-05	Connector, 7P			
S1	S01-1510-15	Rotary switch			

POWER SUPPLY (X68-1270-02)

Ref. No.	Parts No.	Description			
RESISTOR					
R302	R92-0746-05	Metal film	12MΩ	±5%	1W
R303	RC05GF2H335J	Solid	3.3MΩ	±5%	1/2W
R304,305	RC05GF2H226K	Solid	22MΩ	±10%	1/2W
R306	RC05GF2H473J	Solid	47kΩ	±5%	1/2W
R307	RD14BB2E683J	Carbon	68kΩ	±5%	1/4W
R308	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R309	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R310	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R311	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R312	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R313	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R314	RD14BB2E151J	Carbon	150Ω	±5%	1/4W
R315	RN14BK2E1303F	Metal film	130kΩ	±1%	1/4W
R317	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R318	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R319 ~ 321	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R322	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R323	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R324	RD14BB2E333J	Carbon	33kΩ	±5%	1/4W
R325	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R326	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R327	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R328	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R329	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R330	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R331 ~ 333	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R334	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R335	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R336,337	RD14BB2E2R2J	Carbon	2.2Ω	±5%	1/4W
R338	RN14BK2E4301F	Metal film	4.3kΩ	±1%	1/4W
R339	RN14BK2E8201F	Metal film	8.2kΩ	±1%	1/4W
R340	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R341	RN14BK2E1502F	Metal film	15kΩ	±1%	1/4W
R342	RN14BK2E1202F	Metal film	12kΩ	±1%	1/4W
R343	RD14BB2E2R2J	Carbon	2.2Ω	±5%	1/4W
R344	RN14BK2E6801F	Metal film	6.8kΩ	±1%	1/4W
R345	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R346	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R347	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R348	RN14BK2E9102F	Metal film	91kΩ	±1%	1/4W
R349,350	RD14BB2E4R7J	Carbon	4.7Ω	±5%	1/4W
R351	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R352	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R353	RS14GB3D511J	Metal oxide	510Ω	±5%	2W
R354	RD14BB2E151J	Carbon	150Ω	±5%	1/4W
R355	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R356	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R357 ~ 359	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R361	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R362,363	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R364	RD14BB2E105J	Carbon	1MΩ	±5%	1/4W
R365	R92-0778-05	Metal film	7.5MΩ	±5%	1W
VR302	R12-3004-05	Semi-fixed	47kΩB		
VR303	R12-3042-05	Semi-fixed	47kΩB		
VR304	R12-1002-05	Semi-fixed	1kΩB		
CAPACITORS					
C304	CK45E3D102P	Ceramic	1000pF	+100% −0%	2kWV
C305 ~ 308	CK45E3D103P	Ceramic	0.01μF	+100% −0%	2kWV
C309	CK45F1H103Z	Ceramic	0.01μF	+80% −20%	50WV
C310	CE04W1H471	Electrolytic	470μF		50WV
C311	CQ93M1H153K	Mylar	0.015μF	±10%	50WV
C312	C91-0472-05	Film	0.1μF		

PARTS LIST

Ref. No.	Parts No.	Description
C313	CE04W2E3R3	Electrolytic 3.3μF 250WV
C314	CC45SL1H221J	Ceramic 220μF 50WV
C315	CC45CH2H020C	Ceramic 2pF ±0.25pF 500WV
C316	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C317	CC45CH1H100D	Ceramic 10pF ±0.5pF 50WV
C318	CK45D2H332M	Ceramic 3300pF ±20% 500WV
C319 ~ 321	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C322	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C323	CE04W1A331	Electrolytic 330μF 10WV
C324	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C325	CE04W1C221	Electrolytic 220μF 16WV
C326	C90-0218-05	Electrolytic 3300μF 25WV
C327	CE04W1E222	Electrolytic 2200μF 25WV
C328	CE04W1E101	Electrolytic 100μF 25WV
C329	CE04W1H101	Electrolytic 100μF 50WV
C330	CE04W1A331	Electrolytic 330μF 10WV
C331	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C332,333	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C334	CE04W2C100	Electrolytic 10μF 160WV
C335	CE04W2C101	Electrolytic 100μF 160WV
C336	CE04W1E330	Electrolytic 33μF 25WV
C337	CE04W2C100	Electrolytic 10μF 160WV
C338	CK45E3D103P	Ceramic 0.01μF +100% −0% 2kWV
C339,340	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C341,342	CE04W1E100	Electrolytic 10μF 25WV
C343	C90-0298-05	Ceramic, semi-conductor 0.1μF +80% −20% 12WV
C344	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
TC301	C05-0401-05	Ceramic trimmer 20pF
		SEMICONDUCTORS
Q301		Transistor, NPN silicon 2SD401A-(K)
Q302		Transistor, NPN silicon 2SC983-(Y)
Q303		Transistor, NPN silicon 2SC945-(P)
Q304		Transistor, NPN silicon 2SC1628-(Y)
Q305		Transistor, PNP silicon 2SA818-(Y)
Q306		Transistor, NPN silicon 2SC535-(B)
Q307,308		Transistor, NPN silicon 2SC1419-(C)
Q309		Transistor, PNP silicon 2SB633-(E)
Q310		Transistor, PNP silicon 2SB546-(A)
Q311		Transistor, PNP silicon 2SA733-(Q)
Q312 ~ 316		Transistor, NPN silicon 2SC945-(P)
Q317		Transistor, NPN silicon 2SC1384
Q318		Transistor, NPN silicon 2SA684
D301		Diode, silicon, high voltage Y16JA
D302	W02-0401-05	High voltage rectifier block
D304 ~ 306		Diode, silicon 1S2463
D307		Diode, silicon 1SS83
D308 ~ 315		Diode, silicon 1S1555
D316		Diode, zener WZ-050
D317		Diode, zener WZ-075
D318		Diode, zener WZ-150
D319		Diode, rectifier, bridge SIRBA40
D320		Diode, rectifier, bridge SIQB60
D321,322		Diode, silicon 1S1555
IC301		IC, Linear RC4558T

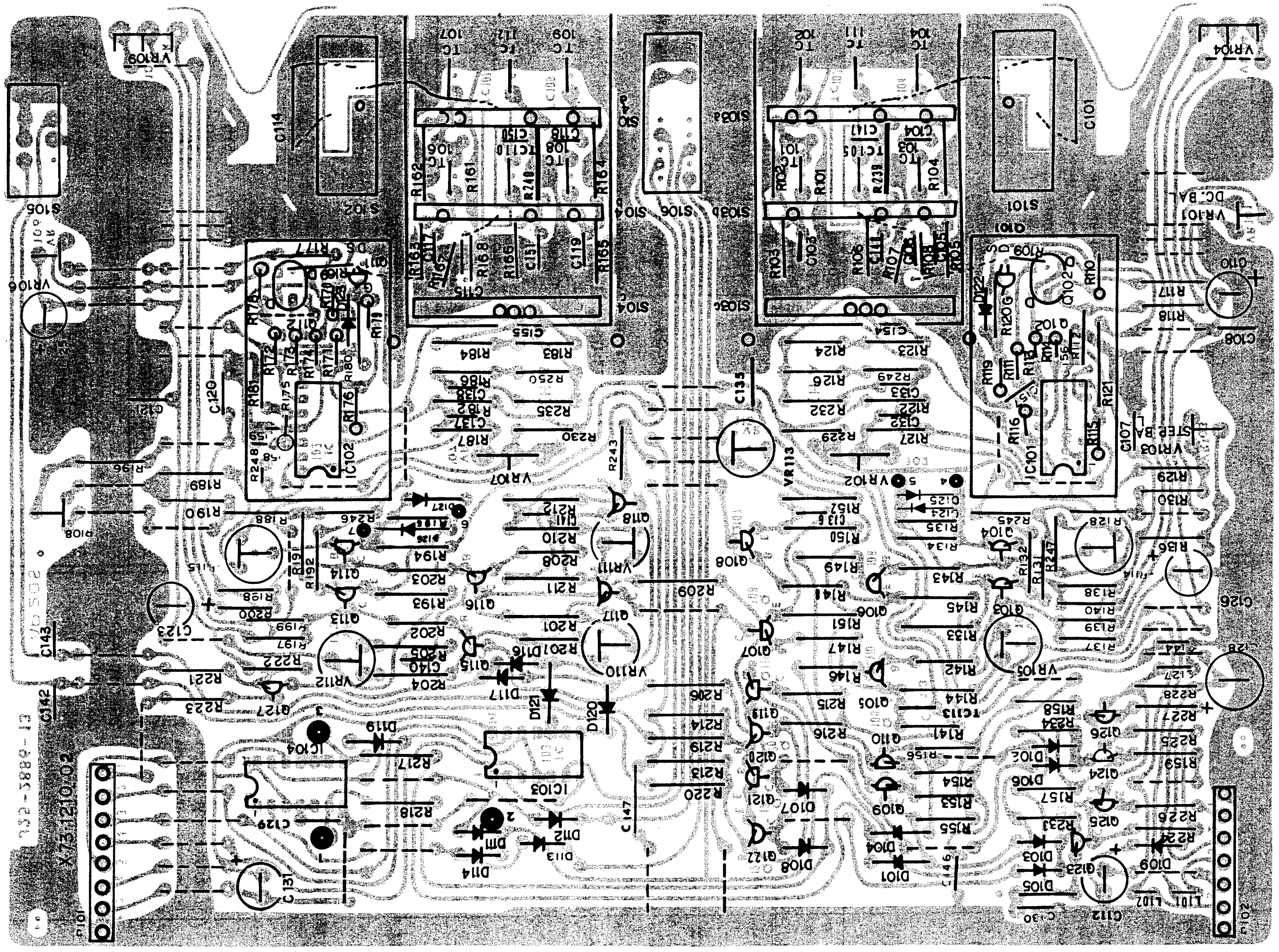
Ref. No.	Parts No.	Description
		MISCELLANEOUS
P301	E40-0903-05	Connector, 9P
P302	E40-0403-05	Connector, 4P
P304	E40-0432-05	Connector, 4P
P305	E40-0532-05	Connector, 5P
P306	E40-0801-05	Connector, 8P
P307	E40-0802-05	Connector, 8P
P308	E40-0367-05	Connector, 3P
P309	E40-0267-05	Connector, 2P
	E23-0047-05	Terminal
—	F01-0801-04	Heat sink
—	F01-0813-05	Heat sink
—	F01-0825-04	Heat sink
—	F05-5016-05	Fuse 0.5A T
	F11-0911-33	Shield case
	F11-0912-04	Shield case
	J42-0017-05	Bushing (rubber)
—	J13-0039-05	Fuse holder
—	J25-2861-33	Printed circuit board
—	J25-2890-04	Printed circuit board
—	J61-0053-05	Supporter (P.C. Board)
N301 ~ 303		Neon lamp NE-2
—	E31-0665-05	Lead wire with connector IP (INTEND)
L301	L40-4711-03	Ferri-inductor 470μH
L302	L40-3391-03	Ferri-inductor 3.3μH
T301	L19-0408-05	Transformer (converter)
TH301		Thermistor SDT-1000

AUTO FOCUS (X68-1270-02)

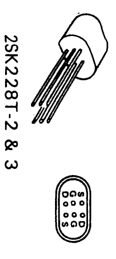
Ref. No.	Parts No.	Description
		RESISTOR
R1	RN14BK2E1101F	Metal film 1.1kΩ ±1% 1/4W
R2 ~ 4	RD14BB2E 101J	Carbon 100Ω ±5% 1/4W
R5	RD14BY2H 473J	Carbon 47kΩ ±5% 1/2W
R6	RD14BB2E 222J	Carbon 2.2kΩ ±5% 1/4W
R7	RN14BK2E9101F	Metal film 9.1kΩ ±1% 1/4W
R8	RN14BK2E5102F	Metal film 51kΩ ±1% 1/4W
R9	RN14BK2E7502F	Metal film 75kΩ ±1% 1/4W
R10	RD14BB2E 103J	Carbon 10kΩ ±5% 1/4w
R11	RD14BB2E 470J	Carbon 47Ω ±5% 1/4W
R12	RD14BB2E 683J	Carbon 68kΩ ±5% 1/4W
R13	R92-0756-05	Metal film 74MΩ ±5% 1/2W
		CAPACITOR
C1	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C2	CK45D1H103M	Ceramic 0.01μF ±20% 50WV
C3	CC45CH2H010C	Ceramic 1pF ±0.25pF 500WV
C4 ~ 6	CK45E3D103P	Ceramic 0.01μF ±100% −0% 2kWV
		SEMICONDUCTOR
Q1		Transistor 2SA1208-(S)
Q2		Transistor 2SC2910-(S)
Q3		Transistor 2SC1360
Q4		Transistor 2SC983(Y)
D1		Zener Diode WZ-050
D3		Diode 1S1555
D4,5		Diode W06C
D6		Diode 1SS83

P.C. BOARD

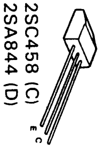
X73-1210-02



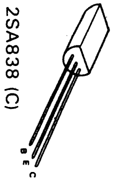
Q102, 112: 2SK228T-2 & 3, Q125, 126: 2SC458 (C), Q107, 108, 117, 118: 2SA838 (C)
Q101, 111: 2SK30A (O), Q123, 124, 127: 2SA844 (D), Q103~106, 109, 110, 113~116, 119~122: 2SC535 (B)
IC101, 102: HA1127, IC103: SN7400N, IC104: SN7472N
D101~108, 122, 123: 1S1587, D109, 111~114, 116, 117, 119~121: 1S1555
D124~127: 1N60



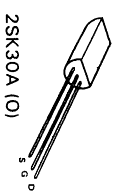
2SK228T-2 & 3



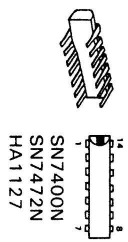
2SC458 (C)
2SA844 (D)
2SC535 (B)



2SA838 (C)

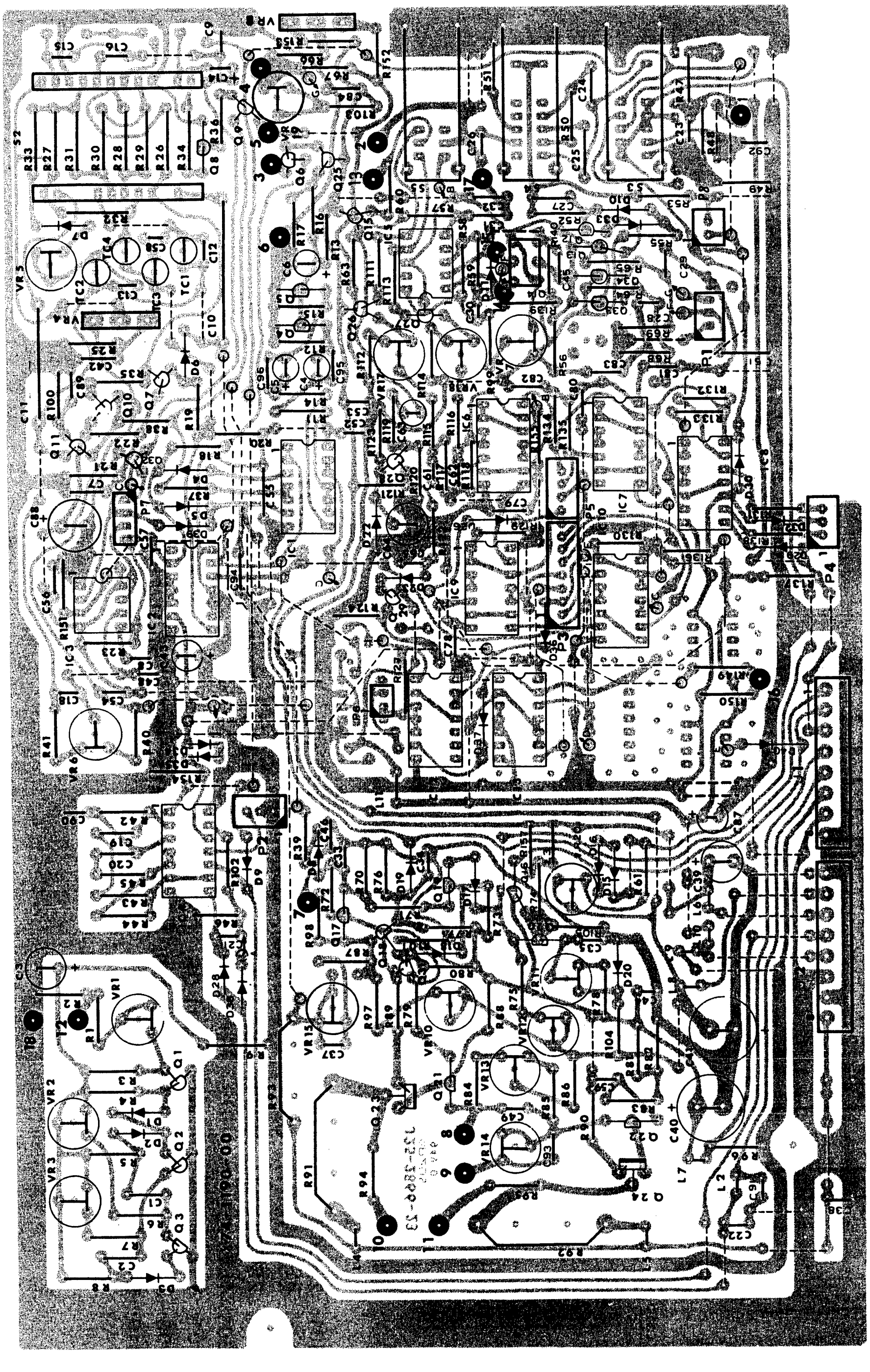


2SK30A (O)



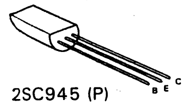
SN7400N
SN7472N
HA1127

P.C. BOARD

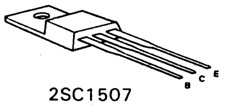


X74-1190-01

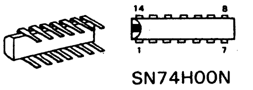
Q1~6, 9, 11, 13, 16~19, 21, 22, 25~29, 31: 2SC945 (P), Q7, 8: 2SA733 (Q)
Q23, 24: 2SC1507, Q10, 12, 15: 2SK30A (O)
IC1: SN74H00N, IC2, 13: SN74H72N, IC3: NJM555D, IC4: SN7400N
IC5: RC733T, IC6~10, 12: SN74LS00N
D1, 5, 11, 30: 1N60, D2~4, 7~10, 15, 17~20, 22, 23, 26, 28, 29, 32~40: 1S1555
D6: 1S1587



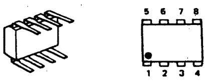
2SC945 (P)
2SA733 (Q)



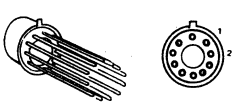
2SC1507



SN74H00N
SN74H72N
SN74LS00N

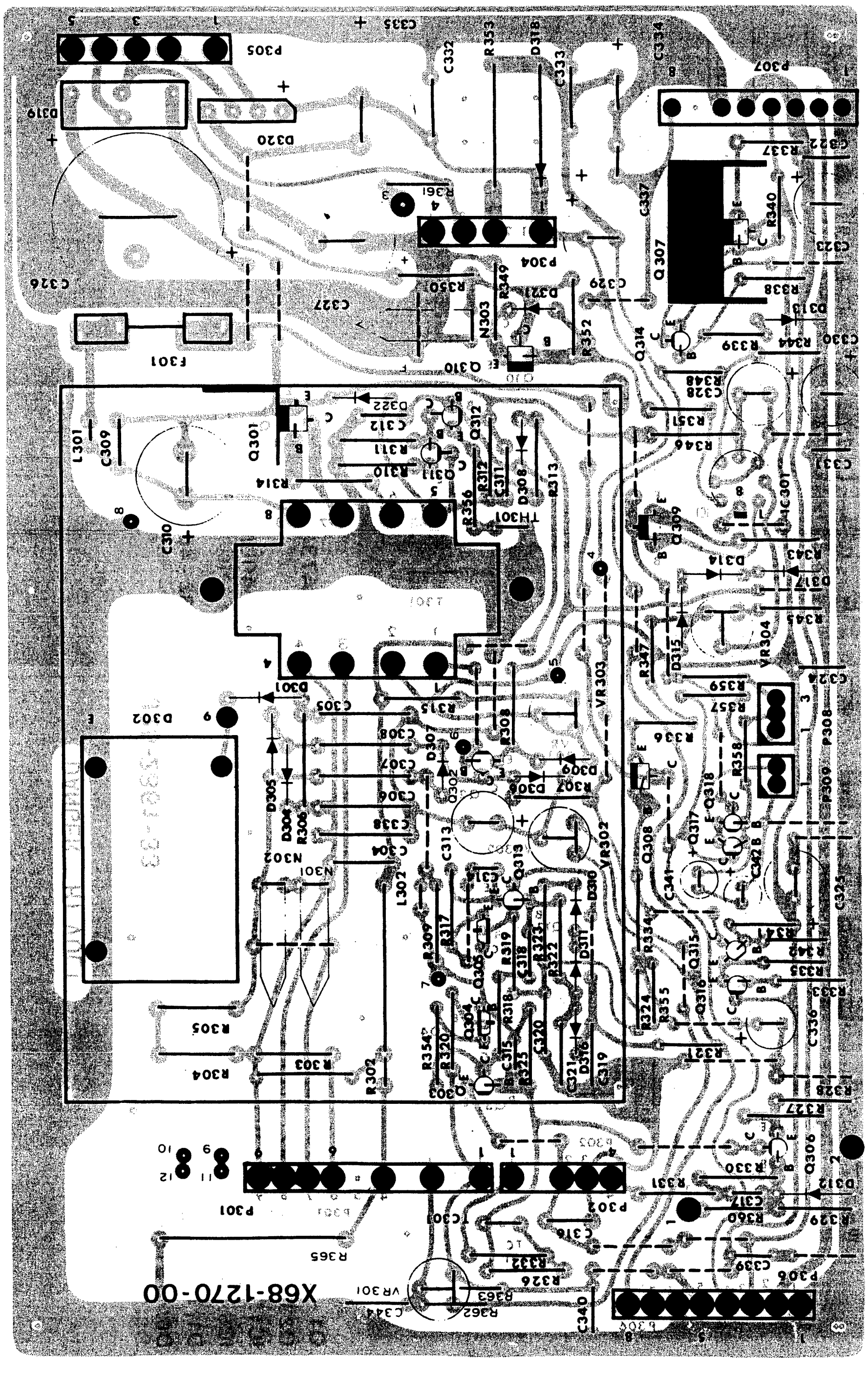


NJM555D


1
2
Bottom view

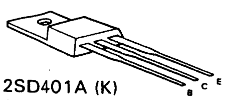
RC733T

P.C. BOARD

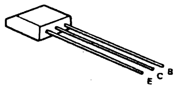

X68-1270-00
P305
P307
P304
P301
P302
P303
P306
P308
P309
T301
F301
IC301
VR301
VR302
VR303
VR304
TH301

X68-1270-02

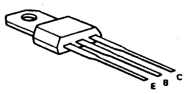
Q301: 2SD401A (K), Q302: 2SC983 (Y), Q303, 312~316: 2SC945 (P), Q304: 2SC1628 (Y)
Q305: 2SA818 (Y), Q306: 2SC535 (B), Q307, 308: 2SC1419 (C), Q309: 2SB633 (E)
Q310: 2SB546 (A), Q311: 2SA733 (Q), Q317: 2SC1384, Q318: 2SA684
IC301: NJM4558T
D301: Y16JA, D302: W02-0401-05, D304~306: 1S2463, D307: 1SS83
D308~315, 321, 322: 1S1555, D316: WZ-050, D317: WZ-075, D318: WZ-150
Q319: S1RBA40, D320: S1QB60



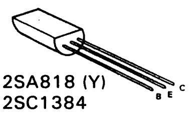
2SD401A (K)
2SB546 (A)



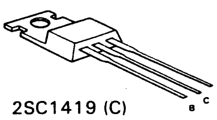
2SC983 (Y)



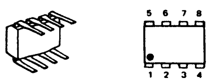
2SC1628 (Y)



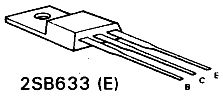
2SA818 (Y)
2SC1384
2SA684



2SC1419 (C)



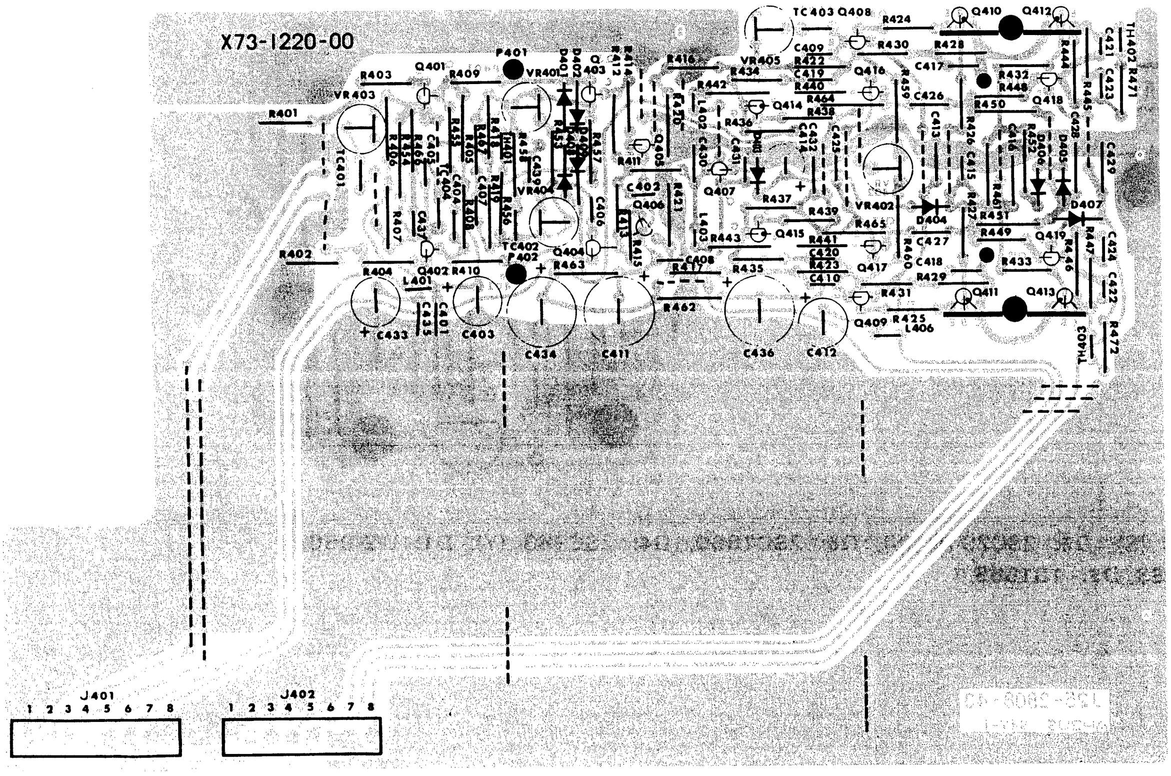
NJM4558T



2SB633 (E)

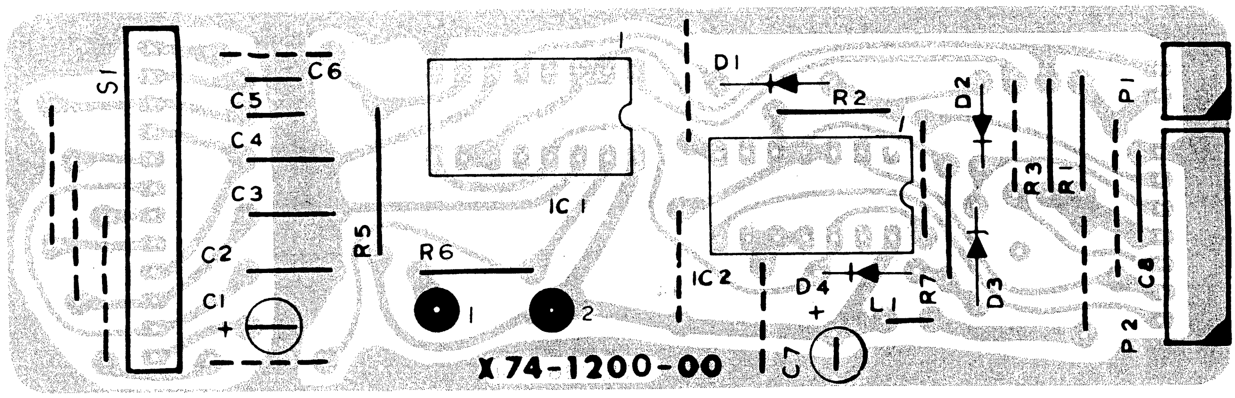
P.C. BOARD

X73-1220-05

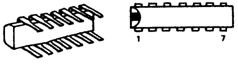

X73-1220-00
TC403 Q408 R424 Q410 Q412
P401 VR401 Q401 R403 R409 VR403 R401
R416 VR405 R422 C409 R430 R428 R434 C419 Q416 C417 R432
R442 R440 R448 R464 R450 Q418 Q414 R438 C426 R436
TC401 Q405 R411 C402 Q406 Q407 R437 R439 VR402 D404 D407 R451 R449 Q419
VR404 TC402 P402 Q404 R463 R443 Q415 R441 R465 C427 C418 R433
R404 Q402 R410 L401 C408 R417 R435 C420 R423 C410 Q417 R429
R402 C433 C403 C434 C411 R462 C436 C412 R431 Q411 Q413 Q409 R425 L406
TH402 R471 TH403 R472 C421 C423 C429 C424 C422
J401 1 2 3 4 5 6 7 8
J402 1 2 3 4 5 6 7 8

Q401~404: 2SC535(B), Q405~409, 418, 419: 2SC458(C), Q410, 411: 2SC1628(Y), Q412, 413: 2SA818(Y), D401, 402, 408, 409: 1S1587, D405, 406: 1S1555, D404, 407: WZ-050, D403: WZ-130

X74-1200-00


S1
C6
C5
C4
C3
C2
C1
+
R5
R6
IC1
1
2
D1
R2
IC2
D4
+
L1
R7
C7
D2
D3
R3
R1
P1
P2
C8
X74-1200-00

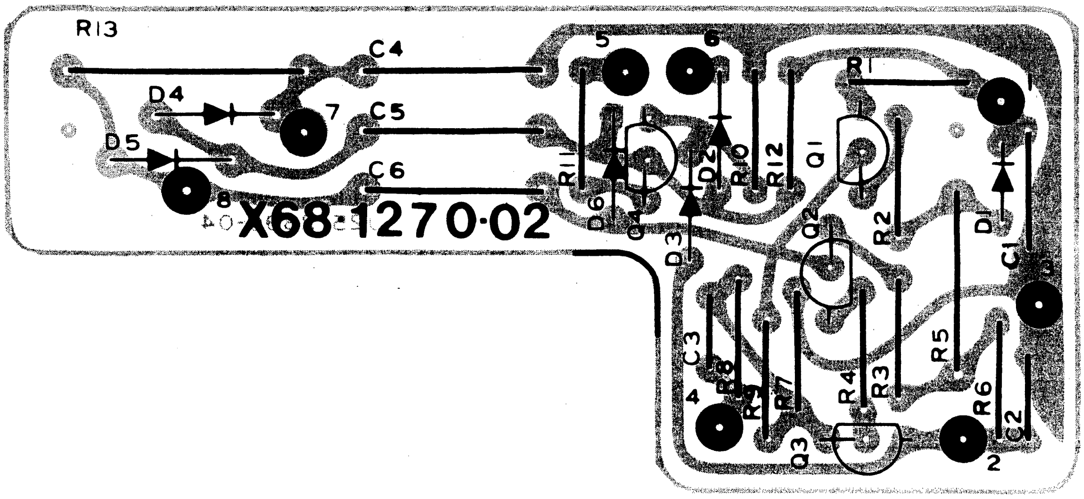
IC1: SN74LS123N, IC2: SN74H72N, D1, 2, 3, 4: 1S1555



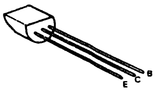
SN74LS123N

P.C. BOARD

X68-1270-02

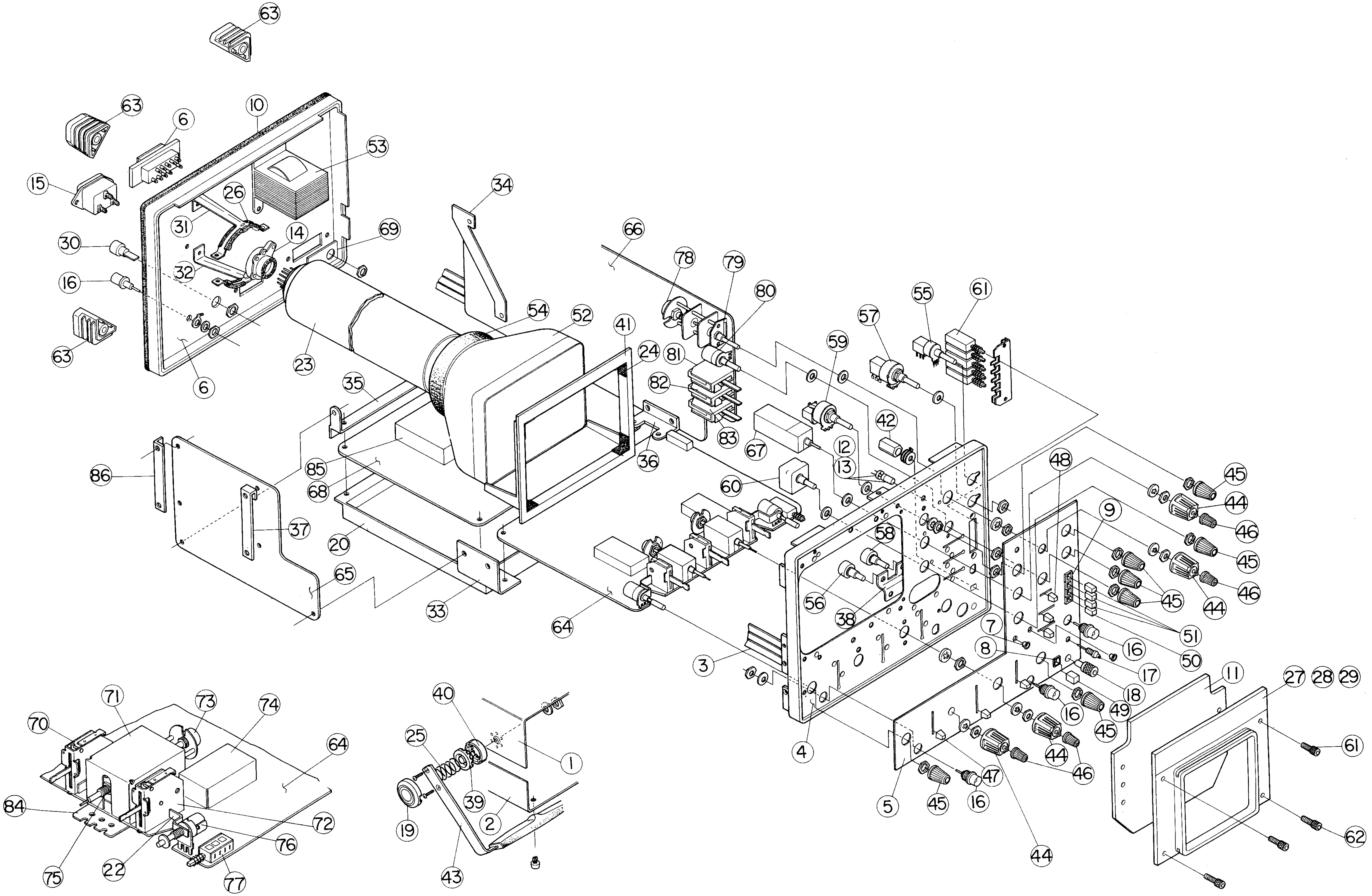

R13
C4
C5
C6
D4
D5
7
8
X68-1270-02
5
6
R11
D6
Q4
D3
D2
R10
R12
Q1
R1
Q2
R2
D1
C1
3
C3
R8
R9
R7
R4
R3
R5
R6
C2
4
Q3
2

Q1: 2SA1208 (S), Q2: 2SC2910 (S), Q3: 2SC1360, Q4: 2SC983 (Y), D1: WZ-050, D2, 4~6: 1SS83, D3: 1S1555



2SA1208 (S)
2SC2910 (S)
2SC1360

DISASSEMBLY



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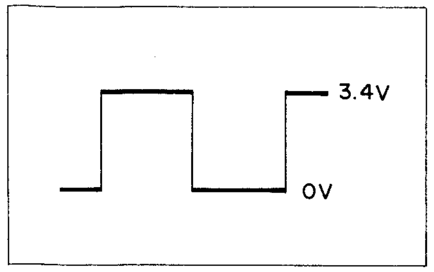
①



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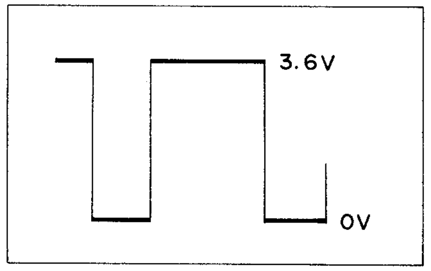

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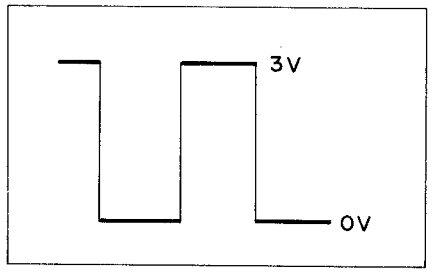

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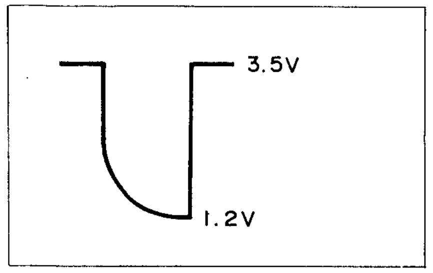

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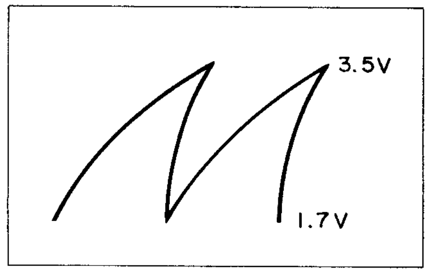

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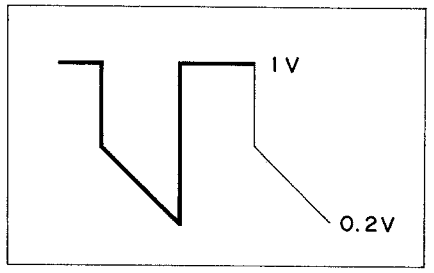

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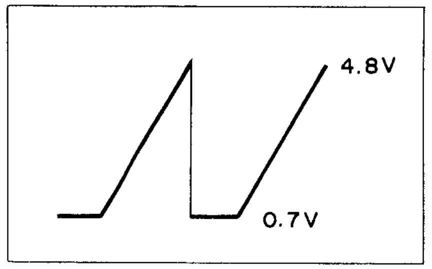

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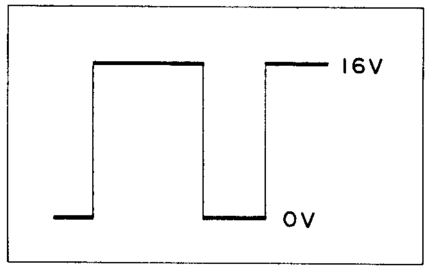

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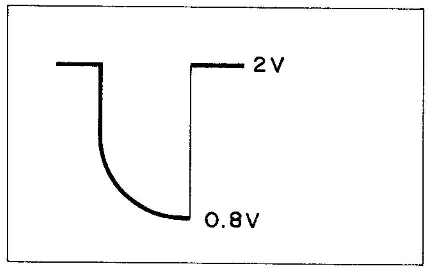

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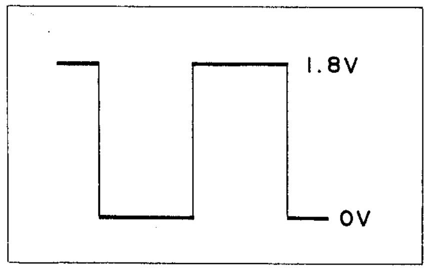

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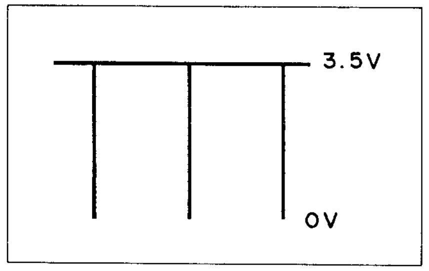

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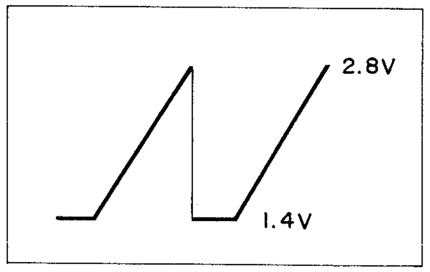

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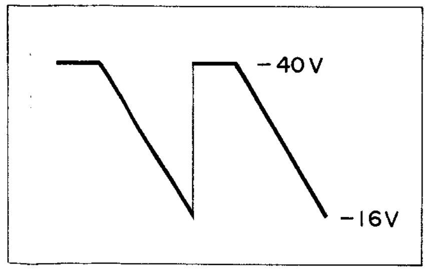

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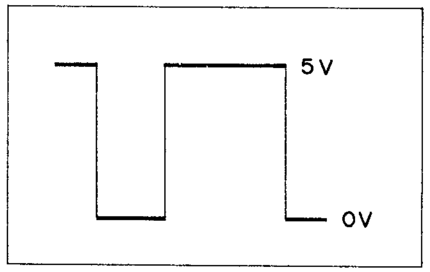

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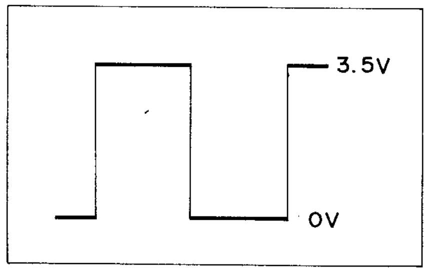

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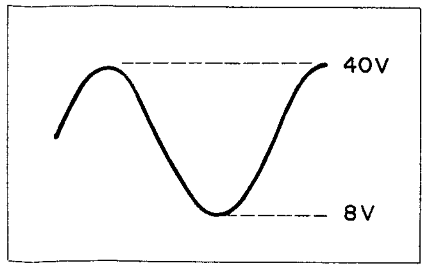

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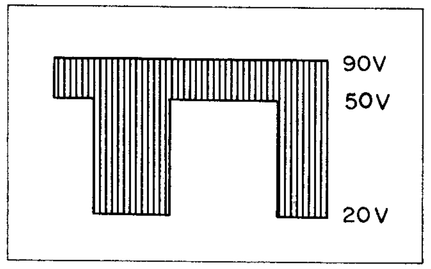

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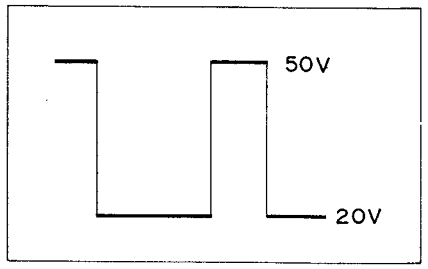
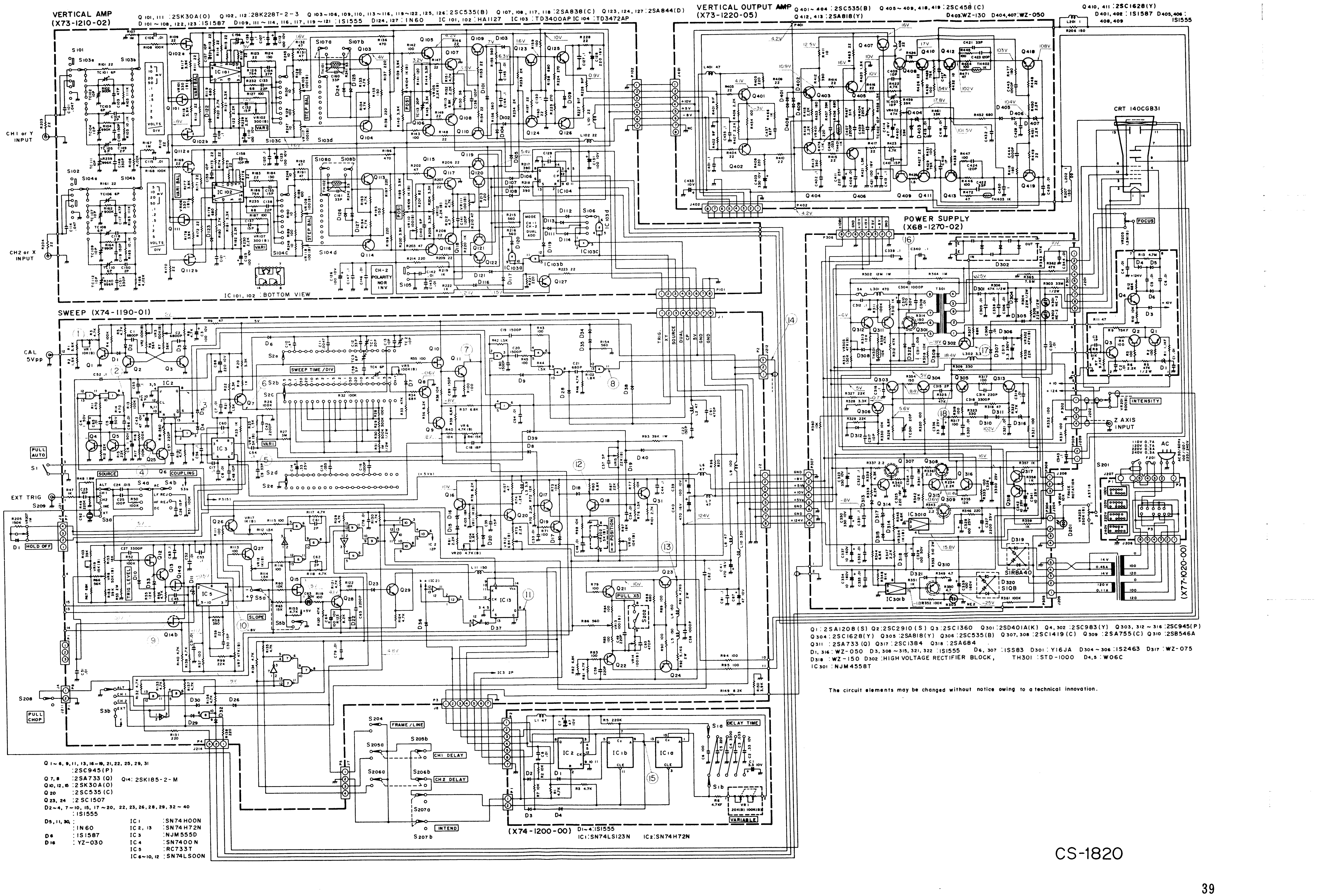


SCHEMATIC DIAGRAM


VERTICAL AMP (X73-1210-02)
VERTICAL OUTPUT AMP (X73-1220-05)
POWER SUPPLY (X68-1270-02)
SWEEP (X74-1190-01)
(X74-1200-00)
(X77-1020-00)
CRT 140CGB31
CH1 or Y INPUT
CH2 or X INPUT
CAL 5Vpp
EXT TRIG
Z AXIS INPUT
FOCUS
INTENSITY
TRACE ROTATION
ASTIG
PULL AUTO
HOLD OFF
SOURCE
COUPLING
TRIG LEVEL
SLOPE
SWEEP TIME/DIV
VARI
POSITION
PULL X5
PULL CHOP
FRAME/LINE
CH1 DELAY
CH2 DELAY
INTEND
DELAY TIME
VARIABLE
IC101, 102 : BOTTOM VIEW
SIRBA40
AC

Q101, 111 : 2SK30A(O) Q102, 112 : 28K228T-2-3 Q103~106, 109, 110, 113~116, 119~122, 125, 126 : 2SC535(B) Q107, 108, 117, 118 : 2SA838(C) Q123, 124, 127 : 2SA844(D)
D101~108, 122, 123 : 1S1587 D109, 111~114, 116, 117, 119~121 : 1S1555 D124, 127 : 1N60 IC101, 102 : HA1127 IC103 : TD3400AP IC104 : TD3472AP

Q401~404 : 2SC535(B) Q405~409, 418, 419 : 2SC458(C)
Q412, 413 : 2SA818(Y) D403 : WZ-130 D404, 407 : WZ-050

Q410, 411 : 2SC1628(Y)
D401, 402 : 1S1587 D405, 406 : 408, 409 1S1555

Q1 : 2SA1208(S) Q2 : 2SC2910(S) Q3 : 2SC1360 Q301 : 2SD401A(K) Q4, 302 : 2SC983(Y) Q303, 312~316 : 2SC945(P)
Q304 : 2SC1628(Y) Q305 : 2SA818(Y) Q306 : 2SC535(B) Q307, 308 : 2SC1419(C) Q309 : 2SA755(C) Q310 : 2SB546A
Q311 : 2SA733(Q) Q317 : 2SC1384 Q318 : 2SA684
D1, 316 : WZ-050 D3, 308~315, 321, 322 : 1S1555 D6, 307 : 1SS83 D301 : Y16JA D304~306 : 1S2463 D317 : WZ-075
D318 : WZ-150 D302 : HIGH VOLTAGE RECTIFIER BLOCK, TH301 : STD-1000 D4, 5 : W06C
IC301 : NJM4558T

The circuit elements may be changed without notice owing to a technical innovation.

Q1~6, 9, 11, 13, 16~19, 21, 22, 25, 29, 31
: 2SC945(P)
Q7, 8 : 2SA733(Q) Q14 : 2SK185-2-M
Q10, 12, 15 : 2SK30A(O)
Q20 : 2SC535(C)
Q23, 24 : 2SC1507
D2~4, 7~10, 15, 17~20, 22, 23, 26, 28, 29, 32~40
: 1S1555
D5, 11, 30, : 1N60
D6 : 1S1587
D16 : YZ-030

IC1 : SN74H00N
IC2, 13 : SN74H72N
IC3 : NJM555D
IC4 : SN7400N
IC5 : RC733T
IC6~10, 12 : SN74LS00N

D1~4 : 1S1555
IC1 : SN74LS123N IC2 : SN74H72N

CS-1820